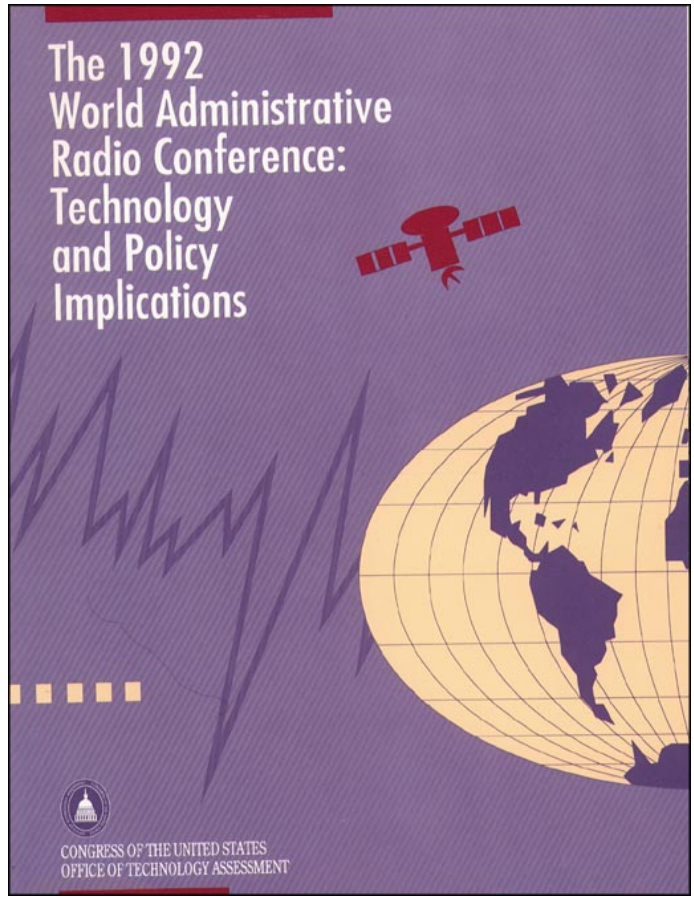
*The 1992 World Administrative Radio Conference: Technology and Policy Implications*

May 1993

OTA-TCT-549
NTIS order #PB93-203727



Recommended Citation:
U.S. Congress, Office of Technology Assessment, *The 1992 World Administrative Radio Conference: Technology and Policy Implications,* OTA-TCT-549 (Washington, DC: U.S. Government Printing Office, May 1993).

For Sale by the U.S. government Printing Office
Superintendent of Documents, Mail Stop: SSOP Washington, DC20402-9328
**ISBN 0-16-041 766-X**

# Foreword

As the 20th century draws to a close, new radio technologies and services are poised to change the ways we communicate. Radio waves already make possible a wide range of services considered commonplace—AM and FM radio broadcasting, television, cellular telephones, remote garage-door openers, and baby monitors. Advances in radio technology are giving birth to even more new products and services, including pocket-sized telephones that may allow people to make and receive calls anywhere in the world, high-definition televisions (HDTV) with superior quality pictures and sound, and static-free digital radios.

The 1992 World Administrative Radio Conference (WARC-92) authorized frequencies for many of these new radiocommunication services, and granted additional frequencies for many existing services, including international broadcasting, satellite-based mobile communications, and communications in space. The effects of these changes will be felt well into the 21st century as countries around the world develop and deploy new communications systems to serve the needs of consumers, businesses, and governments. For the United States, the decisions made at the conference will critically affect how we develop new radio technologies and applications, how competitive this country will be in radiocommunications equipment and services, and how effectively the United States can exercise its role as a leader in world radiocommunication policymaking.

This study of the outcomes and implications of WARC-92 was requested by the House Committee on Energy and Commerce and the Senate Committee on Commerce, Science, and Transportation. OTA was asked to evaluate the success of U.S. proposals at the conference, discuss the implications of the decisions made for U.S. technology and policy development, and identify options for improving U.S. participation in future world radiocommunication conferences. This report complements OTA's assessment of the preparations process for WARC-92, *The 1992 World Administrative Radio Conference: Issues for U.S. International Spectrum Policy.*

OTA acknowledges the contributions of the members of the U.S. delegation to WARC-92, who helped clarify and focus the issues. OTA also appreciates the assistance of the National Telecommunications and Information Administration, the Federal Communications Commission, and the State Department, as well as the numerous individuals in the private sector who reviewed or contributed to this document. The contents of this report, however, are the sole responsibility of OTA.



Roger **Herdman,** Director

# Project Staff

**DAVID P. WYE**
Project Director

**Gregg Festa**
Research Assistant[1]

**Karolyn St. Clair**
Graphics Specialist

**ADMINISTRATIVE**

Liz **Emanuel**
Office Administrator

**Barbara Bradley**
Secretary

**CONTRACTORS**

**Richard G. Gould**
**George Hagn**
Telecommunications Systems

**John Andelin**
Assistant Director, OTA
Science, Information, and
Natural Resources Division

**James W. Curlin**
**Program** Manager
Telecommunication and
Computing
Technologies Program

[1] July-September 1992

# Reviewers and Contributors

João Carlos Fagundes Albernaz
Director-Adjunto
Ministério Da Infra-Estrutura
Departamento Nacional de Administração de Freqüências

Dexter A. Anderson
Telecommunications Manager
Voice of America

Jan Witold Baran
Attorney at Law
Wiley, Rein & Fielding

Jeffrey Binckes
COMSAT Mobile Communications
Communications Satellite Corp.

William M. Berman
Vice President and Director
Global Spectrum Management
Motorola Inc.

Robert Briskman
President
Satellite CD Radio

David Castiel
President
Ellipsat Corp.

Lawrence F. Chesto
Director
Telecommunications Systems
Aeronautical Radio, Inc.

Vary Coates
Senior Associate (Project Director)
Office of Technology Assessment

David J. Cohen
Staff Member
National Telecommunications and Information Administration

William Cook
Director
Electromagnetic Spectrum Management
U.S. Department of Navy

Raymond Crowell
Director
Industry Government Planning
COMSAT

Steve Crowley
Consulting Engineer

Frederick J. Day, Jr.
Attorney at Law
Keller and Heckman

Daniel S. Ehrman, Jr.
Vice President, Finance & Business Affairs
Gannett Broadcasting

Ben C. Fisher
Attorney at Law
Fisher, Wayland, Cooper& Leader

Michael Fitch
Senior Advisor
International Communications and Information Policy
U.S. Department of State

Steven H. Flajser
Vice-President, Space Systems
Loral

Victor E. Foose
Manager, Frequency Engineering Branch
Federal Aviation Administration

William Gamble
Deputy Associate Administrator
National Telecommunications and Information Administration

Tomas E. Gergely
Electromagnetic Spectrum Manager
National Science Foundation

John T. Gilsenan
Deputy Director, Spectrum Policy
Bureau of Communications and Information Policy
U.S. Department of State

Richard G. Gould
President
Telecommunications Systems

Bruce A. Gracie
Head
WARC/CCI Affairs
International Relations Branch
Communications Canada

George H. Hagn
Senior Staff Advisor
Information & Telecommunications Science Center
SRI International

William Hatch
Department of Commerce
National Telecommunications and Information Administration

Gerald B. Helman
Consultant
Ellipsat Corp.

Neal D. Huikower
Associate Department Head
MITRE

Kris Hutchison
Director of Frequency Management
ARINC, Inc.

Waiter E. Ireland
Director
Regulatory Affairs Office
U.S. Information Agency

Karyl A. Irion
Senior Project Staff
Atlantic Research Corp.

Ed Jacobs
Deputy Chief
Land Mobile and Microwave Division
Federal Communications Commission

George Jacobs
Consultant

Bruce Kraselsky
Vice-Chairman
Constellation Communications, Inc.

Walter La Fleur
Director
Engineering & Technical Operations
Voice of America

Todd LaPorte
Analyst
Office of Technology Assessment

Alex Latker
Engineer
Federal Communications Commission

Lon C. Levin
Vice-President and Regulatory Counsel
American Mobile Satellite Corporation

Olof Lundberg
Director General
Inmarsat

Bill Luther
International Advisor
Federal Communications Commission

Robert McIntyre
Chief, International Staff
Private Radio Bureau
Federal Communications Commission

H. Donald Messer
Engineer
Voice of America

John E. Miller
consultant
Stanford Telecommunications

Gary K. Noreen
Chairman and CEO
Radio Satellite Corporation

Janice Obuchowski
President
Freedom Technologies, Inc.

Randall T. Odeneal
General Partner
Sconnix Broadcasting Co.

Larry Olson
Chief, International Branch
Federal Communications Commission

Lawrence Palmer
Program Manager
National Telecommunications and
Information Administration

Alan L. Parker
President
Orbital Communications Corp.

Richard Parlow
Associate Administrator
National Telecommunications and
Information Administration

Geoff W. Perry
Telecommunications Consultant
Societe International de
Telecommunications Aeronautiques
(SITA)

Leonard R. Raish
Attorney at Law
Fletcher, Heald & Hildreth

Michael C. Rau
Senior Vice-President
Science and Technology
National Association of Broadcasters

Edward E. Reinhart
Consultant

Alan B. Renshaw
Program Manager
Starsys Global Positioning

Warren Richards
Chairman of ITU-CCIR
U.S. Department of State

Paul Rinaldo
Consultant

Raui R. Rodriguez
Attorney at Law
Leventhal, Senter & Lerman

Walda Roseman
Director
Office of International
Communications
Federal Communications Commission

Charles Rush
Chief Scientist
National Telecommunications and
Information Administration

Norbert Schroeder
Private Sector Coordinator
National Telecommunications and
Information Administration

Joseph F. Sedlak
Director of Government Relations
Volunteers in Technical Assistance

Jeffrey L. Sheldon
General Counsel
Utilities Telecommunications Council

Herschel Shosteck
Herschel Shosteck Associates, Ltd.

Jean Smith
Contractor
Office of Technology Assessment

Walter Sonnenfeldt
Executive Director
Walter Sonnenfeldt & Associates

Thomas P. Stanley
Chief Engineer
Federal Communications Commission

Ron Strother
President
Strother Communications

Leslie A. Taylor
President
Leslie Taylor Associates

Robert Taylor
Office of Space Operations
National Aeronautics and Space Administration

Thomas S. Tycz
Deputy Chief
Domestic Facilities Division
Federal Communications Commission

Jim Vorhies
National Telecommunications and Information Administration

Thomas Walsh
International Engineer
Federal Communications Commission

Francis Williams
Chief, Treaty Branch
Office of Engineering and Technology
Federal Communications Commission

Kurt A. Wimmer
Attorney at Law
Covington & Burling

Joan Winston
Senior Analyst
Office of Technology Assessment

# Contents


## 1 Summary and Findings, 1

Request for the Study, 2
Introduction, 3
Summary of Findings, 3
WARC-92: The Conference, 9
Themes and Trends From WARC-92 15
Implications for U.S. Policy and Technology Development, 30
Options for Improving U.S. Policymaking, 39

## 2 Outcomes and Implications for U.S. Radio Technology, 51

Factors Complicating Assessment of WARC-92 Outcomes, 51
U.S. Objectives for WARC-92, 54
High-Frequency Broadcasting, 55
Broadcasting Satellite Service-Sound, 64
Terrestrial Mobile Services, 77
Satellite Mobile Services, 86
Other U.S. Allocation Proposals to WARC-92, 128

## 3 Next Steps and Lessons for the Future, 143

International Issues in WARC-92 Implementation, 144
Domestic Context for WARC-92 Implementation, 149
WARC-92: Lessons for the Future, 157
Conference Management, 166

## APPENDIXES

**A Structure and Proceedings of WARC-92, 173**

**B International Observers at WARC-92, 176**

**C Selected WARC-92 Resolutions and Recommendations, 177**

**D Acronyms and Glossary of Terms, 180**

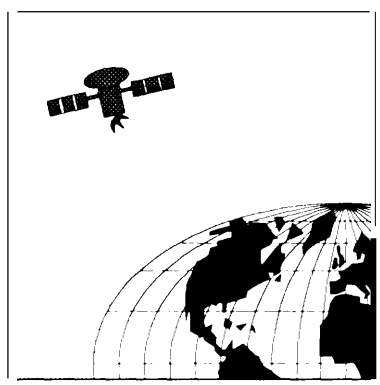
**E Negotiated Rulemaking: An Alternative to Traditional Rulemaking, 184**

## INDEX, 187

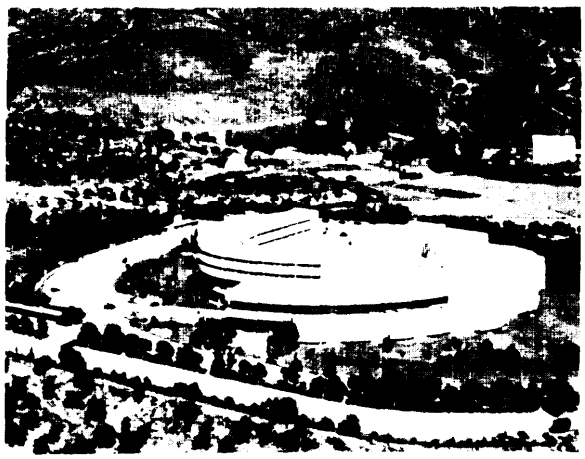



# Summary and Findings 1

For 50 years, radio technologies and services have played an important role in the daily lives of people all over the world. Radio waves carried messages of hope to millions of people caught behind the Iron Curtain. They allowed Americans to see and hear Neil Armstrong's first steps on the Moon. In more recent years, satellite communications have allowed us to witness events from around the globe as they happened—the fall of the Berlin Wall and a lone Chinese student facing an advancing tank in Tiananmen Square. Radio waves also make possible services and technologies considered commonplace today—radio and television programs, cellular telephones, and even microwave ovens, remote garage-door openers, and baby monitors, Advances in radio technology are giving birth to a wide range of new products and services, including pocket-sized telephones that may allow people to make and receive calls anywhere in the world, high-definition television (HDTV) that will provide superior quality pictures and sound, and digital radios that will provide static-free listening.



The process of coordinating the radio frequencies used by different wireless services and systems, and harmonizing radiocommunication policies worldwide is an extremely complex task. Procedures must be developed that allow radio services to share sections of the radio frequency spectrum, and international agreements must be negotiated so that systems and equipment in different countries can interconnect and not interfere with each other. The job of harmonizing and regulating telecommunication and radio services on a worldwide basis falls to the International Telecommunication Union (ITU), a specialized agency of the United Nations. In order to allocate radio frequencies for specific radiocommunication services and to negotiate the rules and regulations that govern the use of those services internationally,


International Telecommunication Union

*For 4 weeks in February 1992, delegates from around the world met in the Palacio de Congresos in Malaga-Torremolinos, Spain for the 1992 World Administrative Radio Conference.*

ITU-member countries periodically gather in World Administrative Radio Conference (WARCs). The latest conference, the **1992** World Administrative Radio Conference (WARC-92), took place in Torremolinos, Spain over the month of February 1992. Among other issues, WARC-92 addressed frequency allocations for a wide range of existing and emerging radio services and sought to define the regulations that will govern them.

Despite the growing role wireless services play, the world of international radiocommunication policymaking is largely removed from public view. The institutions and procedures that guide the development and coordination of wireless services worldwide have long been the province of engineers-not politicians or diplomats. Today, however, as the frequencies used for radiocommunication become increasingly congested, the problems of regulating international uses of the radio spectrum are becoming progressively more complex. And as the connections between radiocommunications, international trade and competitiveness, and national security have become clearer, these problems have begun to draw more high-level attention from American and foreign policymakers.

## REQUEST FOR THE STUDY

**In** November 1991 the Office of Technology Assessment (OTA) released a background paper, *The* 1992 *World Administrative Radio Conference: Issues for U.S. International Spectrum Policy.*[1] That paper examined the technologies and issues to be considered at WARC-92, discussed the international and domestic context for WARC-92 preparations, and analyzed the U.S. process of conference preparation.

To complete the analysis of WARC-92 begun in that paper, the House Committee on Energy and Commerce and the Senate Committee on Commerce, Science, and Transportation requested that OTA prepare a follow-on study that would examine the outcomes of WARC-92 and their implications for U.S. radiocommunications policy. Noting the importance of international radio frequency allocations to emerging and established radiocommunication services and domestic industries, the Committees requested that OTA assess the relative success of the U.S. proposals to WARC-92 and analyze the potential impacts that the conference's decisions might have on domestic radiocommunication services and policymaking, the international competitiveness of the United States in new radio services, and the ability of the United States to achieve its diplomatic and foreign policy goals.

To answer these questions, OTA focused its analysis in three areas:

1. What decisions were reached at WMC-92? What implications will these decisions have on the development of new radio-based technologies and services in this country? How will the decisions of WARC-92 affect

[1] U.S. Congress, Office of Technology Assessment, *The 1992 World Administrative Radio Conference: Issues for U.S. International Spectrum Policy—Background Paper,* OTA-BP-TCT-76 *(Washington DC:* U.S. Government Printing Office, November 1991). Hereafter "O'IX, *WARC-92.*"

U.S. international competitiveness in radiocommunication applications and services internationally?
2. How successful were U.S. proposals to WARC-92? What were the barriers to greater success? What lessons can be drawn from the WARC-92 experience?
3. How does the current structure of radiocommunication policymaking in the United States contribute to and/or detract from the ability of the country to influence international radiocommunication policymaking? What types of organizational or procedural changes might be needed for the United States to adapt to changes in the international procedures for setting international radiocommunication policy?

This report is divided into three parts. Chapter 1 presents an overview of WARC-92, including an analysis of the themes of the conference and a discussion of the factors that will affect implementation of the final decisions. The chapter also presents options for restructuring the U.S. WARC preparation and radiocommunication policymaking processes to better respond to the challenges of the 21st century. Chapter 2 presents a detailed discussion of the allocation and technology issues that were most important at WARC-92, discusses the issues involved in domestic and international implementation of WARC-92 allocations, and considers the implications for existing and emerging U.S. radio technologies and services. Chapter 3 discusses—in the context of WARC-92 outcomes-the preparation for WARC-92, the management of preparations and conference negotiations, and changes that may be needed in the domestic structures and processes for preparing for and implementing decisions made at future world radiocommunication conferences.

## SUMMARY OF FINDINGS

The following section summarizes the conclusions OTA reached as a result of its research. The underlying bases for these findings are discussed in more detail throughout the report.

Overall, United States proposals enjoyed mixed results at WARC-92. U.S. negotiators achieved some notable successes, but also suffered some defeats. On many of the most important and controversial issues considered by the conference, the broad objectives of the United States were achieved. For example, the United States was successful in preventing changes in spectrum allocations that could have harmed important domestic radiocommunication systems and services. The United States was also successful in persuading the conference to adopt allocations for many important new and existing services, including low-Earth orbiting satellite (LEOS) systems, space research and communications systems, and high-frequency broadcasting (see box l-A). However, these successes were often tempered by constraints on how, when, or where the newly-allocated frequencies could be used, It is unclear how serious (and permanent) these limitations will be, and it may not be possible to assess their impact on new radio services until systems begin operation. Thus, the ultimate effects of some WARC-92 decisions are still uncertain, and evaluations of the implications of these decisions must remain tentative.

*United States proposals achieved mixed results at WARC-92.*

Any evaluation of the outcomes and implications of an international conference will be colored by the perspective one takes. WARC-92 is no exception. Depending on how the goals and objectives of the conference are defined, the results are more or less successful. Taking a narrow perspective, and merely comparing U.S. proposals with the results of the conference may lead to an overly negative assessment of the outcomes of WARC-92. Many analysts prefer a

### Box 1-A—Radio Technologies and Services Considered at WARC-92

WARC-92 allocated radio frequencies for many different new and existing wireless services. These services, and the technology systems that will provide them, address a wide range of commercial, public safety and information, and government needs. Over the next several years, technical, economic, and political decisions will be made about how to implement these services, and the regulations agreed to at WARC-92 will substantially affect how, when, and where they can be used. Each of these topics is discussed more fully in chapter 2.

**Mobile Services**—Radio systems that use land-based towers to serve mobile users (in cars, trucks, ships, aircraft, and on foot) are one of the fastest growing segments of the radiocommunication industry. Hundreds of companies around the world have proposed new mobile applications that will deliver a wide variety of new (and old) services, including paging and messaging, telephone, facsimile, data communications, and even imaging and video services. Europe is developing a global system for mobile communications, or GSM, and a future public land mobile telecommunications system (FPLMTS). In the United States, development has centered on personal communication services (PCS).

**Mobile-Satellite Service**—MSS provides many of the same services as terrestrial mobile systems, but uses satellite to serve larger geographic areas and markets. The additional spectrum allocated at WARC-92 may allow the expansion of services by existing providers and may bring more competitors into the market.

**Low-Earth Orbiting Satellites**—LEOS systems are a specific kind of MSS that plan to use a network of between 12 and 66 small satellites in low orbits (typically less than 1,000 miles high versus the 22,300 miles altitude of a geosynchronous satellite orbit), to provide a variety of mobile communication services either regionally, or globally. Two types of LEOS systems have been proposed. "Little" LEOS systems plan to provide position location and data communication services that will allow users to send short text messages to and from almost anywhere in the world. The systems would also be able to find lost hikers, stranded motorists, or lost ships or planes. "Big" LEOS systems plan to use their satellite networks to provide global wireless telephone service, in addition to some data and position services, to international travelers, users not served by cellular systems, and those in remote areas with no telephone service.

**Broadcasting-Satellite Service-Sound**—BSS-Sound refers to the delivery of audio programming (music, news, etc.) from satellites directly to consumer radios. While no BSS-Sound services are operating yet, the systems now being developed would use digital technology to broadcast CD- or near CD-quality programming to listeners, who would receive the programming on radios that would be portable/mobile, low-cost, and able to

broader analysis that recognizes the difficulty of international negotiations and accepts that not all U.S. proposals will be adopted at any given conference. These analysts believe that results are more accurately judged in the context of longer-term negotiating across several conferences and many years. From this perspective, the mixed results of the U.S. proposals at WARC-92 are seen as only the frost step in achieving U.S. objectives, and analysts who take this view see WARC-92 as a success for 'opening the door' to new radio services. The limited successes of WARC-92 will serve as the foundation for future proposals as U.S. representatives pursue frequency allocations and regulations favorable to U.S. radiocommunication interests.

Some analysts, however, prefer an assessment that views WARCs and their outcomes in isolation from the larger radiocommunication policy process. From this perspective, to the extent that U.S. proposals were adopted by WARC-92, the conference was a ''success' '—whatever occurs

receive signals across large geographic areas.[1] Some developers of BSS-Sound systems plan to augment the satellite system with terrestrial transmitters that would improve reception in urban areas (between buildings, in tunnels, etc.). Proponents see many markets for the new digital services, including entertainment, education, paging operations, and navigation and traffic management. In addition to purely domestic services, international broadcasters see BSS-Sound technology as an important new way to eventually transmit their programming—a service that would allow them to reach listeners all over the globe with higher quality than the high-frequency broadcasting they use today.

**High-Frequency Broadcasting**—HF broadcasting allows international broadcasters such as the Voice of America (VOA) and the British Broadcasting Corporation (BBC), as well as religious broadcasters, to transmit their programming around the world. International broadcasts typically include news and information services and religious programming as well as music. Many countries, including the United States, use HF broadcasting to reach people around the world regardless of political boundaries in order to champion their political, cultural, and economic beliefs. In this role, HF broadcasting is viewed by many nations as an important tool of foreign policy. The United States currently broadcasts more hours of international programming than any other country.

**Aeronautical Public Correspondence**—APC services allow airline passengers to make (although not receive, yet) telephone calls while in flight. While such services have become relatively common in the United States, WARC-92 designated frequencies that can be used to provide this service around the world.

**Broadcasting-Satellite Service/High-Definition Television**—WARC-92 also allocated frequencies that will allow programmers to deliver HDTV from satellites. This could provide competition for the traditional cable and broadcast industries in the delivery of the next generation of television programming.

**Space Services**—Various space services, including communication between space vehicles and space research, received allocations at WARC-92. The need for communications to support space activities by the nations of the world has grown significantly in recent years. Radio frequencies are used in space to communicate with manned spacecraft, to command and control satellites, to relay data from remote-sensing satellites to Earth, and to communicate with astronauts working outside their spacecrafts. The United States, for example, uses these frequencies during shuttle missions, for support of the Hubble Space Telescope, and could need them for the planned operations of Space Station Freedom.

[1] Because existing AM/FM radios use analog technology, they will not be able to receive the new digital BSS-Sound signals. Consumers will have to buy new (digital) radios in order to listen to the new services.

SOURCE: Office of Technology Assessment, 1993.

after the conference should be considered separately. OTA believes this perspective is too restrictive and takes the decisions made at WARC-92 out of context—the goals and objectives for U.S. participation in a WARC should advance the larger radiocommunication goals of the United States. Such a narrow perspective may also obscure flaws that might exist in the policy development and/or preparation process.

Concentrating on the "success" or "failure" of **U.S.** proposals may oversimplify the results **of** WARC-92 and may also obscure the nuances of implementing the frequency allocation decisions made at the conference. Several factors will affect how WARC-92 decisions are implemented and what the implications of those decisions will be. First, WARC-92 does not mark the end of international spectrum negotiations, nor does it represent the fma1 resolution of the issues it addressed. It was only one, albeit important, step in the continuous process of allocating and regulating frequencies internation-

ally. Similarly, the agreements reached at WARC-92 are not cast in stone-future negotiations and world radiocommunication conferences may modify or even reverse some of them. This fact works both for and against those who take a‘ ‘long view. ” When decisions are subject to review, it is easier to downplay negative outcomes as only a temporary or minor setback that will eventually be overcome through future negotiations. On the other hand, the successes achieved by U.S. negotiators are also subject to review and/or modification. Winning favorable power limits at WARC-92, for example, does not mean that such limits will not be changed (in ways unfavorable to U.S. interests) based on further studies or operational experiences.[2]

*Agreements reached at WARC-92 are not cast in stone---- future conferences may modify or even reverse some of* them.

Second, many of the details involved in implementing the new allocations and services are yet to be worked out. The decisions reached in Spain must now be adopted by each ITU-member country, and any conflicts in implementing WMC-92 allocations and the systems that will use them will have to be resolved in negotiations between countries. In those bands of frequencies where spectrum must be shared, users will have to work out sharing arrangements to prevent harmful interference. In addition, many of the technical details that will affect the future of these services and technologies are still undecided. WARC-92 called on the International Radio Consultative Committee (CCIR) to conduct studies on the technical aspects of many of the allocations adopted.

Third, WARC-92 assigned long transition times to many services before new allocations can be used, making the implications of WARC-92 difficult to foresee. Some WARC-92 allocations cannot come into effect for 10 or 15 years in order to give existing users of the bands adequate time to move to other frequencies. The full force of some of the decisions made at WARC-79, for example, are just beginning to be felt. Likewise, some WARC-92 allocations are not scheduled to come into effect until 2007, and so it will be many years before their effects will be evident. In the meantime, radio technology will continue to advance, and international and domestic regulations will continue to evolve. Because of this, evaluating the outcomes of WARC-92 is, in one sense, premature. Rather, the outcomes of WARC-92 must be examined as one step in a longer process that stretches out for many years before and after.

Finally, the fact that WARC-92 allocated radio frequencies for new and existing radio services does not guarantee that those services-and the individual systems implemented to provide them-will be technically viable or economically successful. In a broad sense, the final assessment of WARC-92 will depend on how successful U.S. systems will be in domestic and world markets. Consumers and foreign regulators will ultimately determine the outcomes of WARC-92.

The preparation and negotiation of proposals for WARC-92 and the outcomes and implications of the conference cannot be divorced from the broader U.S. radiocommunication policy process. From this perspective, lack of integrated, long-term radiocommunication planning by U.S. spectrum managers and policy makers hurt U.S. preparations for WARC-92 and now threatens to undermine

[2]Commenters have pointed out that this outcome makes WARC-92 a‘ ‘success. ’ However, since the limits agreed to at the conference may be changed, this victory may ultimately prove hollow.

the successes achieved at the conference.[3] Driven primarily by advances in technology and a commitment to improving competitiveness, the perspective of both government and industry has been too narrowly focused on merely gaining access to new radio frequencies. As a result of the rush to prepare positions for WARC-92—and now to license services—larger policy issues have been overlooked or neglected, and insufficient consideration is being given to the long-term consequences of implementing new technologies and services. The result has been an often reactive and short-sighted approach to spectrum policy--once frequencies are allocated, other issues can be addressed later. This problem is exacerbated because radiocommunications policy development and spectrum management in the United States is divided between the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA), with input from the Department of State on international issues. No common vision or policy goals currently unite these agencies, and although new leadership may bring more foresight to the process, institutional inertia and personal ambivalence about the prospects of radiocommunication planning among spectrum managers may frustrate the development of new policy directions. Preparations and negotiations for future world radiocommunication conferences will be impaired if radiocommu - nication policymaking continues to be fragmented and unfocused.

Past approaches to international radiocommunication policy development and negotiations may no longer produce the most successful outcomes for the United States at future conferences. While U.S. technologies and markets still lead the world in many wireless services, new international competitors will challenge the United States to develop more cooperative strategies that rely less on U.S. market power and more on developing consensus and agreement with new (and old) allies around the world. Several trends evident during the preparations for and negotiations at WARC-92 are challenging traditional U.S. approaches to international policymaking.

- The rapid development of new radio technologies and applications, the explosion of demand for wireless communication services, and the consequent increase in congestion of the radio frequency spectrum have put great pressures on the structures and processes for managing radio-based communications both domestically and internationally. Finding space on the airwaves for new technologies and services is becoming increasingly difficult, and many counties, including the United States, have become more protective of their existing uses of the spectrum. Balancing the needs of existing and emerging uses of the radio frequency spectrum will become one of the most critical technological and political problems facing U.S. telecommunications policymakers.
- Economics and politics have begun to play a greater role in the way spectrum is allocated both internationally and domestically as radio services have assumed a greater role in world communications and commerce. The economic stakes involved in the decisions of WARCs are huge, and as a result, decisions and proposals regarding spectrum use are often no longer based primarily on technical criteria. In trying to develop domestic radiocommunication policy and prepare for WARCs, U.S. spectrum managers must often contend with politically powerful users, large invest-

[3]The Institute of Electrical and Electronics Engineers–United States Activities (IEEE-USA) recently noted the over-concentration on short-term domestic issues to the detriment of long-tam planning and accommodation of international concerns. See Comments of the Institute of Electrical and Electronics Engineers before the National Telecommunications and Information Administration, Notice of Inquiry in the matter of *Current and Future Requirements for the Use of Radio Frequencies in the United States,* Docket No. 920532-2132, released June 1, 1992.

ments in equipment, and users with long histories of successful operation and public service. Internationally, maintaining and promoting the competitiveness of U.S. products and services in world radiocommunication markets and protecting vital national (security) communication systems are increasingly important goals of U.S. international spectrum policy.

- In this newly economically-driven context, government and private sector representatives are especially concerned about the rise of regional blocks of countries that are uniting to protect and advance their economic interests in international meetings such as WARC-92. These coalitions can wield significant power in forums such as the ITU, with its one-nation, one-vote process, and could effectively work against U.S. interests at future world radiocommunication conferences. These regional groups also often have enormous technological, manufacturing, and/or market power that could pose a serious threat to U.S. competitive interests in global markets. On the other hand, these new alignments may present the United States with an important opportunity to cultivate support for U.S. positions.
- As telecommunications industries have been deregulated and privatized and as markets have been liberalized around the world, the private sector and radiocommunication user groups have begun to play an increasingly important role in the development of international spectrum policy. This rise may portend important changes in the role of the ITU in international spectrum regulation. Negotiations that previously involved only governments will in the future more directly include a variety of spectrum "special interest groups"—private sector and extra-governmental organizations that represent important international users of radiocommunications—the world aviation community, for example. These international groups were evident at WARC-92 and worked hard behind the scenes to have their concerns addressed.

  The rise of such groups and the increasing involvement of the private sector in international regulatory affairs pose a substantial challenge for U.S. policymakers. The problem is that the interests and goals of transnational companies and organizations will not always match those of the United States. Even those companies based in the United States may have trouble supporting U.S. positions if those positions conflict with their own international interests or with the interests of their industry. In the future, government spectrum managers must be watchful that U.S. companies participating in international conferences support U.S. positions and do not promote their own special interests to the detriment of specific U.S. objectives. A strong policy focus must be maintained if the United States is to be successful in influencing international radiocommunication policymaking.
- Finally, the ITU recently restructured itself and its processes to better meet the challenges presented by these changes. In this new environment, the United States is being forced to reexamine traditional assumptions about how the spectrum is allocated and how radiocommunication policy should be set. Reliance on purely market-based approaches to spectrum policy are likely to be inadequate to protecting and promoting U.S. technological competitiveness and policy leadership in future international policy decisions.

In order to maximize the success of U.S. proposals at future world radiocommunication conferences, the current structure and processes of radiocommunication policymaking in the United States will have to change. Institutional organization, responsibilities, and

procedures for future world radiocommunication conferences must be reexamined. Current levels of funding for WARC preparation and negotiation may be inadequate with future conferences now slated to occur every 2 years. Planning, preparation, and negotiation for these biennial meetings will become continuous activities, replacing the more sporadic efforts for past conferences. Centralizing WARC preparation could streamline decisionmaking and eliminate the funding disparities between agencies that characterized WARC-92. Options for improving WARC preparations-and radiocommunication policy in general—are discussed at the end of this chapter.

A critical long-term concern for U.S. spectrum managers and policymakers is balancing important national economic and security interests against the broader goals of international cooperation, integration, and regulatory accord. In some cases, legitimate U.S. radiocommunication requirements may not match global needs. However, U.S. policy makers must be wary of advocating positions that too often conflict with world needs or that run the risk of isolating the United States from the world radiocommunication community. Many analysts believe that an isolationist approach could decrease U.S. effectiveness in international radiocommunication policymaking in the long term. Thorough evaluations must be made of the foreign policy implications of U.S. positions, and international considerations must be weighed carefully in developing U.S. domestic and international spectrum policies. U.S. spectrum managers must also develop better guidelines to balance the needs of new and existing spectrum users, More open and effective procedures are needed to compare and evaluate proposals from competing government agencies and between the government and the private sector.

Cooperation between U.S. Government and private sector interests is generally good during WARC preparations and negotiations. Although each group vigorously pursues its own interests, and conflicts are hard-fought, both sides work together to develop U.S. positions and policies. In large part, this spirit of cooperation is the result of the extensive network of personal relationships that have been built over many years, and the prior experience *many in the* private sector gained while working for the government. The downside of this cooperative process is that sometimes it is unclear who is in charge of formulating U.S. international spectrum policy—the Federal Government or the private sector and its consultants. Despite such problems, however, this network of individuals could form a foundation for the future development of aggressive and forward-thinking U.S. radiocommunication policy, if guided by clear and creative guidelines and a focused policy development process.

*Sometimes it is unclear who is in charge of formulating U.S. 'international spectrum policy—the Government or private sector.*

## WARC-92: THE CONFERENCE

WARC-92 began on February 3 and ended March 3, 1992. More than 1,400 delegates attended the conference representing 127 of the ITU's 166 member countries.[4] The conference was also attended by observers from 31 international and regional organizations (see appendix B). Fifty-three official delegates from the United States participated in the deliberations in Spain,

[4]The number of countries has fluctuated rapidly in recent years as countries have consolidated (East/West Germany and North/South Yemen) and as the member states of the former Soviet Union-the Ukraine and the Republic of Belarus, for example-have sought to enter the ITU as independent members. Delegates from 124 countries attended WARC-92, with 3 (Belize, Latvia, and Liechtenstein) represented by proxy.




*More than 1,400 delegates representing 127 countries participated in the deliberations of WARC-92.*

representing a wide range of interests from the Federal Government and the private sector (see table l-l). Jan Witold Baran, a lawyer from Washington, DC, served as head of the U.S. delegation, a position that confers temporary ambassadorial status. A support staff of 18 additional representatives provided technical and administrative assistance to the delegation at the conference, and approximately 30 more U.S. citizens attended all or part of the conference as observers and informal advisers.[5] During the conference, a "home team" of approximately 40 government and private sector representatives remained in the United States and provided additional technical and policy guidance to the delegation in Spain.

The work of WARC-92 was functionally divided among a variety of committees (see appendix A for a description of the formal seven-committee structure of WARC-92). The most important work, and the majority of formal negotiations, at WARC-92 was conducted in the meetings of Committee 4 (the Allocations Committee), and Committee 5 (the Regulatory Committee). These committees distributed their work to ad hoc and drafting groups in which small groups of delegates forged agreements on specific topics and developed regulations for implementing changes. The supreme body of WARC-92 was the plenary, which was chaired by the Honorable Jose Barrionuevo Peña of Spain.[6] It was at the plenary sessions that decisions were formally and finally agreed to-most of the Plenary sessions took place in the last several days of the conference.

The decisions made at WARC-92 resulted from a complex mixture of formal committee meetings and extensive informal discussions outside of the formal meeting structure. These informal discussions, during which much of the real work of the conference--negotiation and persuasion—took place, were held during coffee breaks between sessions, at lunches around town, and at after-hours meetings anywhere there was space. The agreements reached at the conference

Table 1-1—WARC-92 Delegates'

| | |
|---|---|
| **Department of Commerce** | **8** |
| **Department of Defense**[b] | **5** |
| **Department of State** | **7** |
| **Federal Communications Commission** | **9** |
| **Other Government** | |
| **National Aeronautics and Space Administration** | **2** |
| **National Science Foundation** | **1** |
| **Coast Guard** | 1 |
| **U.S. Information Agency** | **2** |
| **Federal Aviation Administration** | **1** |
| **Private Sector** | **35** |

a Includes support staff.
b Includes Army, Navy, and Air Force.

NOTE: Some private sector delegates worked as contractors supporting various government agencies.

SOURCE: Office of Technology Assessment, 1993, based on U.S. Delegation Report.

[5]The United States was the only delegation to send a separate "support staff. " In practice these individuals performed duties that closely resembled those of the formal delegates, although they were not considered delegates by ITU and did not have direct access to working documents, except through fellow delegates.

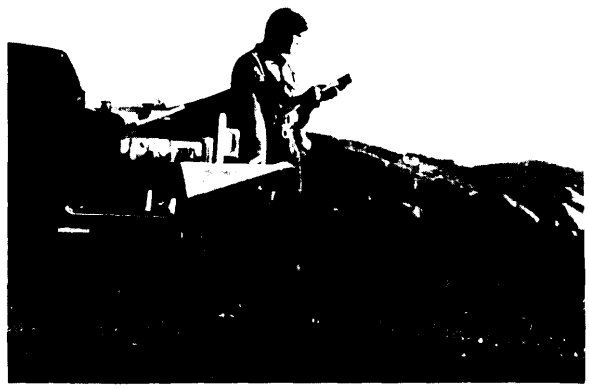
[6]For conferences held outside Geneva (home base for ITU), the chairman of a WARC is traditionally provided by the country hosting the conference. Five vie-chairs, including Ambassador Jan Baran, the head of the U.S. delegation were selected by the delegates to assist the chair. Delegates from the Russian Federation Cote d'Ivoire, China, and Norway served as the other vice-chairs.

were based on consensus and compromise, although informal polls were sometimes taken to gauge support and/or opposition to a specific proposal. Although formal voting on issues is provided for in the rules of the ITU, it is usually only used as a last resort, and no formal votes were taken at WARC-92. This was considered a minor victory by some members of the U.S. delegation, since the United States was isolated on some issues and had only tentative support on others. Formal voting on these issues could have been embarrassing for the United States.

As a result of the month-long negotiations, WARC-92 allocated frequencies to a number of emerging radiocommunication services and systems, including low-Earth orbiting satellite (LEOS) systems,[7] broadcasting-satellite services for audio broadcasting (BSS-Sound), and HDTV. See box 1-A for brief descriptions of these services. The conference also expanded the frequency allocations for the Mobile-Satellite Service (MSS), high-frequency (HF) broadcasting, and a variety of space research and operations services. Box 1-B summarizes the allocations made at WARC-92 and figure 1-1 shows a sample page from the Final Acts of WARC-92. Chapter 2 discusses the allocations in greater detail.

WARC-92 differed from past WARCs in several respects. It was the first WARC in more than 12 years to attempt a broad revision of the international Table of Frequency Allocations. As opposed to the WARCs of the 1980s, which generally concentrated on one service-mobile, high-frequency broadcasting, or space communication services--WARC-92 addressed a wide range of allocation issues covering many segments of the radio spectrum. Compounding the breadth of the conference, the time allotted to WARC-92 was short, both for preparations-less than 2 years-and for the conference itself.

Magellan Systems, Corp.



*New radiocommunication services will permit people to communicate to and from almost anywhere in the world.*

WARC-92 was limited to only 4 weeks; however, for previous WARCs, the ITU had allotted substantially longer time.

Most analysts believe that WARC-92 was probably the last broad reallocation conference that will be held. At a special plenipotentiary held in December 1992, the ITU adopted a new timetable for future radiocommunication conferences.[8] According to that schedule, WARCs, renamed ''world radiocommunication conferences,' would be held every 2 years. Most observers expect these conferences to be narrower in focus than WARC-92-concentrating on one service or area of the spectrum, more like the WARCs of the 1980s. The format and working procedures of future conferences were also changed in order to streamline decisionmaking and reflect the increasing role of the private sector in international telecommunications policymaking. The full impact of these changes will not be felt for several years, however, since some of the agreed-to changes have not yet been imple-

[7] Two types of LEOS systems were considered by WARC-92. "Little" LEOS systems plan to provide data and position-location services and will operate in the VHF/UHF frequencies. ''Big" LEOS will provide telephone services in addition to data, and will operate in frequencies above 1 GHz.

[8] See OTA, *WARC-92*, op. cit., footnote 1 for further discussion of the organization and functioning of the ITU.

## Box 1-B—Summary of WARC-92 Allocations

WARC-92 allocated frequencies for a number of new and existing radiocommunication services. The allocations, however, do not tell the whole story of the decisions made at WARC-92. All of the allocations summarized below are subject to limitations and constraints that are described in footnotes to the allocations and in various resolutions and recommendations the conference adopted for each service. These footnotes, resolutions and recommendations are examined in more detail in chapter 2.

### High-Frequency (HF) Broadcasting

A total of 790 kHz was allocated to HF broadcasting with 200 kHz located in frequencies below 10 MHz (the most congested portion of the HF bands), and 590 between 11 and 19 MHz. All the newly allocated bands are allocated on a worldwide basis, all are subject to planning, and all must use single sideband (SSB) modulation for transmission.

| | |
|---|---|
| 5900-5950 kHz | 3800-13870 kHz |
| 7300-7350 kHz | 3570-13600 kHz |
| 9400-9500 kHz | 5600-15800 kHz |
| 11600-11650 kHz | 7480-17550 kHz |
| 12050-12100 kHz | 8900-19020 kHz |

### Broadcasting-Satellite Service-Sound (BSS-Sound)

| | |
|---|---|
| 1452-1492 MHz | Worldwide, except the United States |
| 2310-2360 MHz | Only in the United States and India |
| 2535-2655 MHz | Various countries in Europe and Asia |

All BSS-Sound operations are required to use digital audio broadcasting (DAB) technology.

### Broadcasting-Satellite Service-High-Definition Television

| | |
|---|---|
| 17.3-17.8 GHz | ITU Region 2 only |
| 21.4-22.0 GHz | ITU Regions 1 and 3 |

### Terrestrial Mobile Service

| | |
|---|---|
| 1700-2690 MHz | Upgraded to primary status worldwide |
| 1885-2025 MHz & 2110-2200 MHz | Intended for Future Public Land Mobile Telecommunications Systems (FPLMTS) worldwide. Frequencies for a satellite component of FPLMTS were also identified. |

### Mobile-Satellite Service

MSS allocations are made in pairs—one set of frequencies for transmission from the Earth to satellites (uplinks) and one set for transmissions from satellites to Earth (downlinks).

| | |
|---|---|
| 1492-1525 MHz (downlink) | Region 2 only, not allocated in the United States |
| 1675-1710 MHz (uplink) | Region 2 only |
| 1525-1559 MHz (downlink) | Portions remain allocated specifically to land, maritime, and aeronautical services, but the United States has allocated almost the entire band to generic MSS.[1] |

[1] With the exception of 1545-1555 MHz, which remains allocated to the aeronautical mobile satellite service.

| | |
|---|---|
| 1626.6-1660.5 MHz (uplink) | As above, portions remain allocated to specific (land, maritime, and aeronautical) services, but the United States has allocated the majority of the band to generic MSS.[2] |
| 1930-1970 MHz (uplink) | On a secondary basis for Region 2 only. |
| 2120-2160 MHz (downlink) | On a secondary basis for Region 2 only. |
| 1980-2010 MHz (uplink) | With an additional 10 MHz allocated at 1970-1980 MHz for Region 2 only. |
| 2170-2200 MHz (downlink) | With an additional 10 MHz allocated at 2160-2170 MHz in Region 2 only. |
| 2500-2520 MHz (downlink) | |
| 2670-2690 MHz (uplink) | |
| **Low-Earth Orbiting Satellites** | |
| Using frequencies above 1 GHz (big LEOS): | |
| 1610-1626.5 MHz (uplink) | Upgraded to primary |
| 2483.5-2500 MHz (downlink) | |
| 1613.8-1626.5 MHz | Allocated (secondary status) for downlinks in order to permit bidirectional use of the band. |
| Using Frequencies Below 1 GHz (little LEOS): | |
| 137-138 MHz (downlink) | Portions of which are secondary |
| 148-149.9 MHz (uplink) | Secondary in more than 70 countries |
| 400.15-401 MHz (downlink) | |

**Space Services**

A number of allocations were made to various space services, including space research, space operations, and Earth exploration satellite services. Frequencies were allocated in the 400-420 MHz bands for space communications and research, in the 2 GHz bands for space research, operations, and Earth-exploration satellite service, and in the bands above 20 GHz for inter-satellite links, Earth-exploration satellite, and (deep) space research services.

**Aeronautical Public Correspondence**

1670-1675 MHz was allocated worldwide for ground-to-aircraft communications, to be paired with 1800-1805 MHz for aircraft-to-ground transmissions. The United States will maintain its existing system at 849-851 MHz and 894-896 MHz.

**Fixed-Satellite Service**

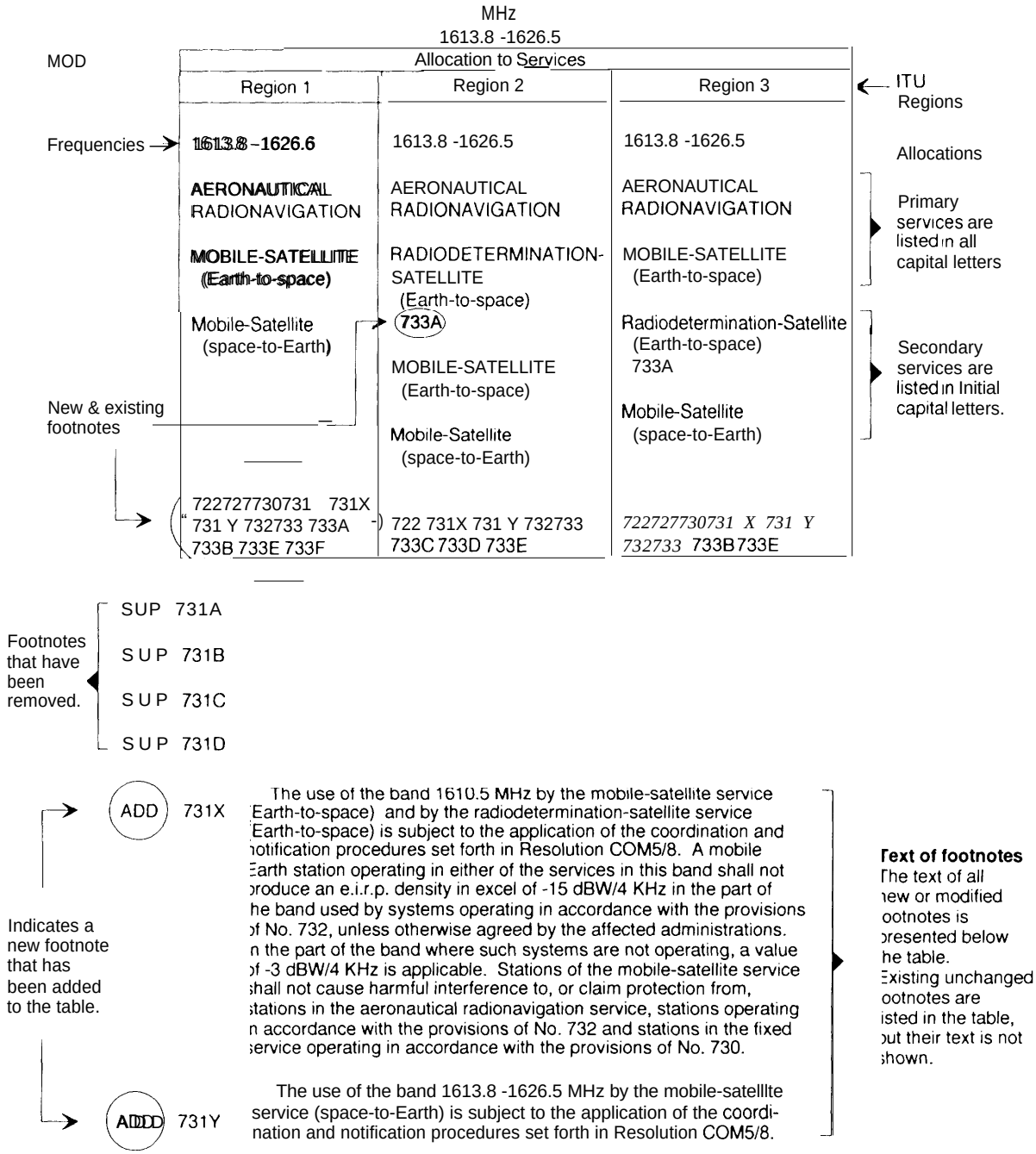
A worldwide allocation was made at 13.75-14.0 GHz.

---

[2] With the exception of 1646.5-1656.5 MHz, which remains allocated exclusively to aeronautical mobile satellite service.

SOURCE: Office of Technology Assessment, 1993.

**Figure I-I-Sample Page From Final Acts of WARC-92**




SOURCE: Office of Technology Assessment, 1993, with information from International Telecommunication Union, *Final Acts of the World Administrative Radio Conference* (WARC-92), provisional version, Malaga-Torremolinos, March 1992.

mented. In order to evaluate the implications of these changes for the United States, the Department of State has convened a task force under the auspices of the U.S. national CCIR/International Telegraph and Telephone Consultative Committee (CCITT) committee structure. That group will also study possible improvements in U.S. structures and procedures that could allow the United States to participate more effectively in the new ITU.

## THEMES AND TRENDS FROM WARC-92

A number of broad trends complicated the negotiations leading up to and at WARC-92, and several important themes were evident at the conference that will influence the course of future ITU proceedings and meetings. U.S. spectrum policymakers and managers must take account of these trends in order to ensure the success of U.S. negotiating efforts for future world radiocommunication conferences.

### Spectrum Negotiations Are Becoming Increasingly Difficult

The overarching message to come out of WARC-92 is how difficult it has become to achieve international consensus on spectrum matters. WARC-92 has been described as one of the most difficult international radio conferences in memory. The issues were technically complex and interrelated. New geopolitical realities had redefined who the important players were, and economic concerns drove countries to protect their existing radio services and users with a tenacity rarely seen before.

WARC-92 came very near to failing entirely.[9] Twenty-four hours before the scheduled end of the conference, several major allocation issues remained unresolved-future public land mobile telecommunications systems (FPLMTS), MSS, and BSS-Sound—and delegates talked openly about calling a formal halt to the proceedings. If that had occurred, it is possible that no decisions would have been accepted, no new allocations would have been made, and more than 2 years of preparation would have been left unfulfilled.

Several factors made WARC-92 difficult. First, the agenda for the conference changed (and expanded) substantially over time. originally, WARC-92 was conceived as a limited conference that would resolve issues left over from previous WARCs and address a small number of new allocations for space and mobile services. After the initial scope of WARC-92 was set by the 1989 ITU Plenipotentiary Conference, however, it was expanded considerably at the 1990 ITUAdministrative Council meeting. At that meeting, the United States added many new items to the agenda, including frequency allocations for 'little' LEOS, terrestrial supplements to BSS-Sound, and some new space services. Even after the agenda was finalized in 1990, however, the range of topics to be addressed continued to grow. Companies in the United States unveiled plans in late 1990 for "big" LEOS systems that would provide telephone service in addition to data communications, and that would require a frequency allocation all their own. Because these systems are a type of Mobile-Satellite Service, they were considered at WARC-92 as part of the MSS negotiations. The result of this expansion was that issues became more complex and interrelated, more viewpoints had to be accommodated, and government and private sector resources were stretched very thin. Nonetheless, the broader agenda did force WARC-92 to consider many (new) topics in which the United States had important interests.

[9] In ITU parlance, ''fail' seems to have a specific mcaning, although there is disagreement over exactly what it is. Some delegates believe that if a conference fails, it is adjourned without any final agreements being signed—even on those issues where decisions had been reached. Others believe that the conference could sign a partial agreement on items that had been agreed to. No WARC has ever ended this way, but the threat of "failure' was used at WARC-92 to push delegates to compromise.

## Technology Issues: Existing Services or New Uses?

The clearest theme governing the negotiations at WARC-92 was the battle between existing and new technologies-how to find room in the spectrum for new technologies and services while accommodating the existing users of the spectrum. The spectrum is already completely allocated from 9 kHz up to 275 GHz (300 GHz in the United States), and many of these frequencies, especially in the bands below 6 GHz are heavily used (see box 1-C for a brief description of radio waves and the radiospectrum).[10] And while policymakers and engineers in the United States continue to propose ways to make more efficient use of the spectrum and accommodate more users, congestion continues to increase.[11] Thus, new systems and services trying to gain access to radio frequencies often must contend with entrenched users with long histories of serving public (and private) needs and who have large investments in equipment.

*Delegates struggled to find spectrum for new technologies while accommodating existing users of the spectrum.*

In the U.S. preparation process, the battle over the 1435-1525 MHz band of frequencies illustrates this tension. Proponents of satellite-delivered audio broadcasting wanted to use a portion of this band to deliver BSS-Sound services. The band, however, is already used by the Federal Government and aerospace companies to provide aeronautical telemetry (tracking, data relay, etc.) services in support of aircraft testing and missile development.[12] Debate over the U.S. proposal(s) for these frequencies was intense.

At WARC-92, the battle between old and new was clearly evident. On most issues, countries sought to protect their existing services, in which they have often invested millions or billions of dollars, while simultaneously promoting new technologies and services with the potential to provide new or better services where none existed before or that could advance their competitive interests. This battle often separated the developed and developing countries. Developing countries, because of sunk investments and a lack of resources to modernize, often resisted new allocations that could make their existing systems obsolete. Developed countries, on the other hand, which are generally better able to implement new technologies more rapidly, were the major force pushing allocations for new types of radio services. Although resource problems face both developing and developed countries, large-scale changes in systems may be more keenly felt in developing countries, many of which lack the funds and personnel to make such changes. Such countries are likely to need financial and technical help to implement new systems. Recognizing these problems, WARC-92 adopted Resolution 22, which calls on the ITU's Telecommunications Development Bureau (BDT) to provide assistance to countries in need.[13]

---

10 OTA, *WARC-92*, op. cit., footnote 1.

11 Congress, for example, has been considering legislation for several years that would take spectrum from the government and make it available to the private sector. The FCC has put great emphasis on sharing spectrum and competition in its recent proceedings, and has attempted to encourage innovation and Spectrum-efficient applications in its Pioneer's Preference ruling. NTIA has initiated a study looking at the long-range spectrum needs of the country. Scholars, policymakers, and industry analysts alike are debating the value of auctions for assigning spectrum rights. See OTA, *WARC-92*, op. cit., footnote 1 for further discussion of the technical developments affecting spectrum congestion.

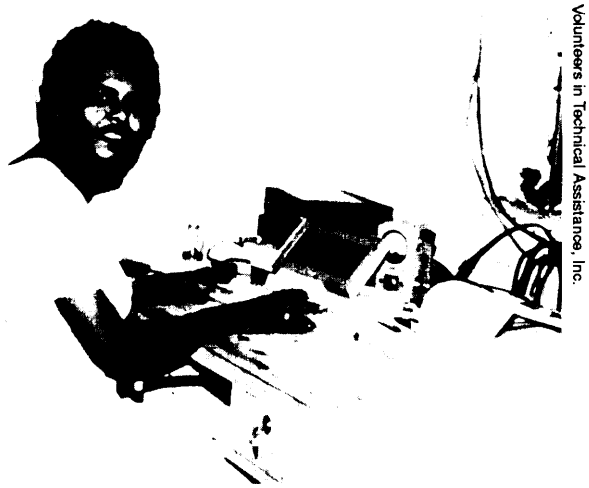
12 MSS proponents also wanted t. use the band for mobile services. For more information on the history of this debate, see OTA, *WARC-92*, op. cit., footnote 1.

13 International Telecommunication Union, *Final Acts of the World Administrative Radio Conference (WARC-92)*, Resolution 22. Hereafter, "ITU, *Final Acts.*"

As the spectrum becomes more crowded and congested, convincing existing users in the United States and abroad to share or give up their spectrum will become increasingly difficult. American strategists and policymakers must recognize that convincing incumbents to share spectrum or move will require sustained efforts in political, economic, and technical persuasion. As part of these efforts, the United States may wish to target programs and funding that would help developing countries modernize their (radio) communication services and infrastructures. Such funding, in combination with direct private sector aid to these countries, would make U.S. systems and services more affordable and accessible internationally, and could promote demand for U.S. technology and equipment overseas. Such a strategy may also help counter efforts on the part of other countries, notably Japan and several European countries, to build international markets for their telecommunications equipment.

## The Rise of Regional Blocks

Another important trend evident at WARC-92 was the linking of countries in groups in order to more forcefully present their positions. WARC-92 was the first WARC held under the banner of the 'new world order.' The USSR had dissolved, and its control over a strong block of Eastern European countries had almost vanished.[14] The historic North-South divisions that separated the developing and developed countries for many years had lessened, replaced on many issues (but not all) by divisions between blocks of countries, each united by common regional and economic concerns. Among these, a unified block of




*New satellite technologies will enable people in remote parts of the world to access many kinds of information and receive technical assistance tailored to their specific needs--all at low cost.*

European countries, represented by the Conference of European Postal and Telecommunications administrations (CEPT), was the strongest at WARC-92. The developing countries, as a group, exhibited little of the unity and cohesiveness they have shown in the past. However, toward the end of the conference, under the guidance of Mr. Abderrazak Berrada of Morocco, many of the developing countries, especially from Africa and the Middle East, were able to exercise considerable control over debate on many important issues.[15] While other regional blocks did not show the cohesiveness and determination of CEPT, some countries of the Asian Pacific and Latin America were able to cooperate on specific issues—indicating their potential emergence as a force to be reckoned with at future conferences.

14 The Russian Federation did send a delegation to WARC-92, as did the Ukraine and the Republic of Belarus. The delegates for these new countries were, by and large, the same individuals that had represented the USSR in the past, and they usually acted together in their proposals and negotiations. By most assessments they were an effective, although limited, force at WARC-92.

15 At past conferences, developing countries often would setup (or threaten) votes on specific issues they knew they had a majority for. In this way, they could more directly control the outcomes of the conferences. At WARC-92 their impact was much more benign, if important-no votes were taken, but the number of potential votes commanded by Mr. Berrada was an important force in making the developing countries voices heard and forcing concessions out of the developed countries.

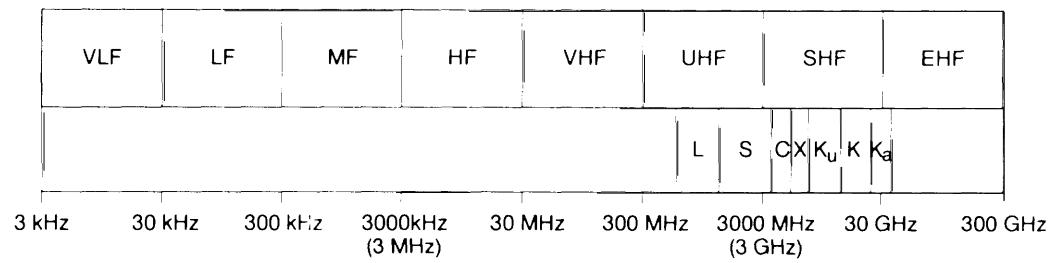
## Box 1-C—The Radio Frequency Spectrum

Radiocommunication refers to the process of sending and receiving information that is carried by radio waves. Radio waves have a number of distinguishing characteristics, but they are most often identified by their frequency. The frequency of a radio wave is the number of cycles it completes in 1 second. Radio frequencies are measured in Hertz; 1 Hertz equals 1 cycle per second. Higher frequencies are described as multiples of Hertz:

1 kHz (kilohertz) = 1 thousand cycles per second;
1 MHz (megahertz) = 1 million cycles per second;
1 GHz (gigahertz) = 1 billion cycles per second.

The radio frequency spectrum refers to the total range of frequencies that can be used for communications. Today this range extends from 3 kHz to 300 GHz. Over time, the spectrum has been divided into "bands" that correspond to specific ranges of frequencies. These bands are often referred to by descriptive terms like "high frequency" or "ultrahigh frequency" (see figure 1-C-1). These general terms are listed in table 1-C-1, along with some of the radio services that use the bands. Terms such as "L-band" or "X-band," which are used extensively today, came into use during World War II in order to keep secret the specific frequencies used by radars and other radio devices. Because of their transmission characteristics, some of the most valued and congested frequencies are between 1 and 3 GHz—the L- and S-bands.

**Figure 1-C-1—Frequency Band Designations**




SOURCE: Office of Technology Assessment, 1993, based on Richard G. Gould, "Allocation of the Radio Frequency Spectrum," OTA contractor report, Aug. 10, 1990.

### CONFERENCE OF EUROPEAN POSTAL AND TELECOMMUNICATIONS ADMINISTRATIONS

The most powerful bloc at WARC-92 was CEPT, representing 32 European countries.[16] CEPT members are the telecommunications regulatory authorities from each participating country. For the past several years, CEPT has been gaining the attention of U.S. international spectrum experts as it has become more coordinated and able to present a more unified front at international meetings. In forums such as WARC-92, where each country has one vote, such a unified group can potentially command a substantial number of votes, and this power gives an enormous amount of leverage in conference negotiations. At WARC-92, CEPT was closely coordinated, presenting common positions on most of the items the conference considered. The tight cohesiveness

16 Although CEPT is almost unanimously regarded as the most powerful single force at WARC-92, curiously, little mention has been made as to how effective the European bloc was at the conference. While such an evaluation is outside the scope of this report, future studies of the CEPT organization and processes might provide valuable lessons for the United States as it plans for future conferences.

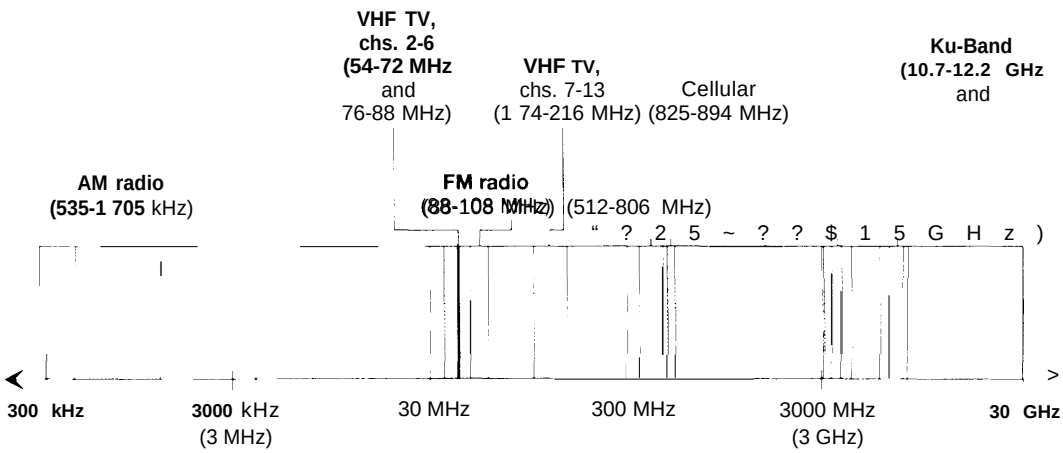
**Table I-C-I—Radio Frequency Bands** and Uses

| NAME | Frequency range | Examples of services |
|---|---|---|
| Very low frequency (VLF) | 3 to 30 kHz | Marine navigation |
| Low frequency (LF) | 30 to 300 kHz | Marine and aeronautical navigation equipment |
| Medium frequency (MF) | 300 to 3,000 kHz | AM radio broadoast, LORAN maritime navigation, long-distance aeronautical and maritime navigation |
| High frequency (HF) | 3 to 30 MHz | Shortwave broadcast, amateur radio, CB radio |
| Very high frequency (VHF) | 30 to 300 MHz | Private radio land mobile services such as police, fire, and taxi dispatch; TV channels (2 through 13); FM broadcasting; cordless phones; baby monitors |
| Ultrahigh frequency (UHF) | 300 to 3,000 MHz | UHFTV channels; cellular phones; common carrier point-to-point microwave transmission used by long-distance phone companies; satellite mobile services |
| Superhigh frequency (SHF) | 3 to 30 GHz | Radar, point-to-point micowave, and satellite communication |
| Extremely high frequency (EHF) | Above 30 GHz | Satellite communioations and space research |

SOURCE: Harry Mileaf (cd.), *Electronics One,* revised 2n Ed. (Rochelle Park, NJ: Hayden Book Co., Inc., 1976), p. 1014; and John J. Keller, "No Vacancies," The Wall Street Journal, Nov. 9,1990, p. R14.

Individual radiocommunication services use specific bands of frequencies, which are allocated to them at world administrative radio conferences (WARCs). FM radio broadcasting, for example, uses the 88-108 MHz band (see figure 1-C-2). In many cases, however, bands of frequencies are shared by different services. In the lower part of the radio spectrum, for example, frequency bands are often shared by fixed (point-to-point) and mobile radiocommunication services.

Figure I-C-2—Radio Frequency Spectrum and Selected Services




NOTE: This figure uses a logarithmic scale with dashed lines representing breaks in the scale. Shaded areas in different segments of the scale are not proportional. For example, AM radio occupies 1,170 kHz of spectrum, while cellular (which appears smaller visually) actually occupies 69,000 kHz of spectrum.

SOURCE: Office of Technology Assessment, 1993.

and determined approach of the CEPT countries made CEPT a strong, almost immovable force on many issues.[17]

In analyzing the performance of CEPT at WARC-92, some observers and delegates tend to see CEPT as a monolithic group that would not compromise on any issue. In large part, this view stems from CEPT's unwillingness to compromise on the high visibility MSS (including big LEOS) issues that were priorities for the United States. Individual European countries were often unwilling to change their positions so as not to break down the unity of the CEPI'positions.[18] However, while it is true that CEPT's lack of flexibility made it difficult to negotiate with on several important issues, on other matters CEPT was reportedly more willing to compromise. In the debate over BSS-Sound, for example, internal divisions in CEPT forced a change in its position.

The perceived inflexibility of the CEPT bloc (and the United States' own determination) appears to have had at least one positive outcome. Delegates from both sides agree that such rigidity undermined the ability of Europe and the United States to negotiate before and at WARC-92, and that more flexibility in negotiations might produce better outcomes at future conferences. This realization may lead to more productive discussions and negotiations between the United States and Europe prior to the next world radiocommunication conference.

The role of CEPT in future international spectrum negotiations is somewhat unclear due to continuing reorganization of its structure and functions. Prior to 1987, CEPT was composed of telecommunications regulators, systems operators, and telecommunications services providers. In that year, the role of CEPT was redefined and the scope of its power diminished by transferring standards development activities to the European Telecommunications Standards Institute (ETSI). In September 1992, CEPT reorganized again, and now consists solely of telecommunications regulators, with system operators and services providers forming a separate group.[19] Within CEPT, the focal point of radiocommunication policymaking is the European Radiocommunications Office (ERO), which evaluates spectrum use and development, manages spectrum interests, and develops long-term spectrum policy.

As a result of these restructurings, CEPT activities have become increasingly focused on regional and international radiocommunications policymaking-with the goal of promoting greater harmonization of European policies. This concentration, and the slowly increasing political and economic unification of Europe, may eventually strengthen CEPT as an organization and bring it to the forefront of European radiocommunication policy development. However, at the end of 1992, the various European organizations (including CEPT, ETSI, and the European Community (EC)) had not settled all the jurisdictional and procedural battles over radiocommunication policy. It is still too early to tell if restructuring will make the European process more or less effective, and what impact these efforts will have on European performance at future world radiocomrmmication conferences.

Aside from its new focus on radiocommunications policy, regional changes could bolster Europe's and CEPT's position. Driven by economic concerns, for example, the nations of Europe are becoming increasingly united on trade and competitiveness issues—a trend that may

---

17 The behavior of CEPT at WARC-92 has been likened to a battleship-large and powerful, but slow to maneuver.

18 In addition t. the CEPT group, the European Community had its own representatives at WARC-92. Some U.S. delegates to WARC-92 believe that this group was present to enforce the solidarity of the European countries at the conference. Several observers, however, note that such pressures were resisted by CEPT members, especially those not belonging to the EC, and that the relationship between the EC and CEPT representatives was strained at best.

19 Andreas Evagora, ''cEn: Radio Interference, '' *Communications Week International,* July 20, 1992, p. 4.

foreshadow greater cooperation on radiocommunication policy development in order to support common economic goals. With the dissolution of the USSR, the newly independent countries of Eastern Europe have been seeking alliances with Western Europe, including joining CEPT or the EC (see figure 1-2). CEPT's numbers (and hence the number of potential votes CEPT would represent) will likely swell in the next several years. A larger CEPT representing more countries at future conferences could pose a substantial challenge to U.S. negotiators and policymakers.

### INTER-AMERICAN TELECOMMUNICATIONS CONFERENCE (CITEL)

The countries of the Western Hemisphere have their own forum for coordinating telecommunications policies, CITEL.[20] However, in the past, CITEL has served little more than a discussion function for its members; it has not been an effective force for coordinating regional radio- or telecommunication policies. In preparation for WARC-92, many of the countries in the Western Hemisphere, including the United States, made a concerted effort to build regional cooperation-at least in part in response to the perceived power of the CEPT alliance-in order to present a stronger, more united front at the conference. Two formal meetings were held in an attempt to work out common positions, and working groups were set up to develop common views that could be used by all CITEL members to form the basis for their own national proposals.[21] Despite recognition of the importance of such activities and extensive discussions between countries, no formal common proposals/positions were adopted.

During the conference, CITEL had little more success in building a stronger presence and promoting regional views. A schedule of meetings had not been set up in advance of WARC-92 and formal discussions were held only in the last 2 weeks of the conference. Ambassador Baran hosted a luncheon for CITEL members, but only a few countries attended. The CEPT countries, on the other hand, met daily to update members on late-breaking news and to develop negotiation strategies and responses. In the end, the CITEL effort was ineffective because members could not agree on common views.

The ineffectiveness of CITEL at WARC-92 is the result of several factors. There is little historical tradition of cooperation between the countries in the Western Hemisphere on telecommunication matters. CITEL has been underfunded by the Organization of American States, its parent organization, for many years. Perhaps most importantly, the countries that participate in CITEL are a more heterogeneous group-politically, economically, and culturally-than the countries that belong to CEPT. There are fewer natural and historical linkages that can be used to promote cooperation.

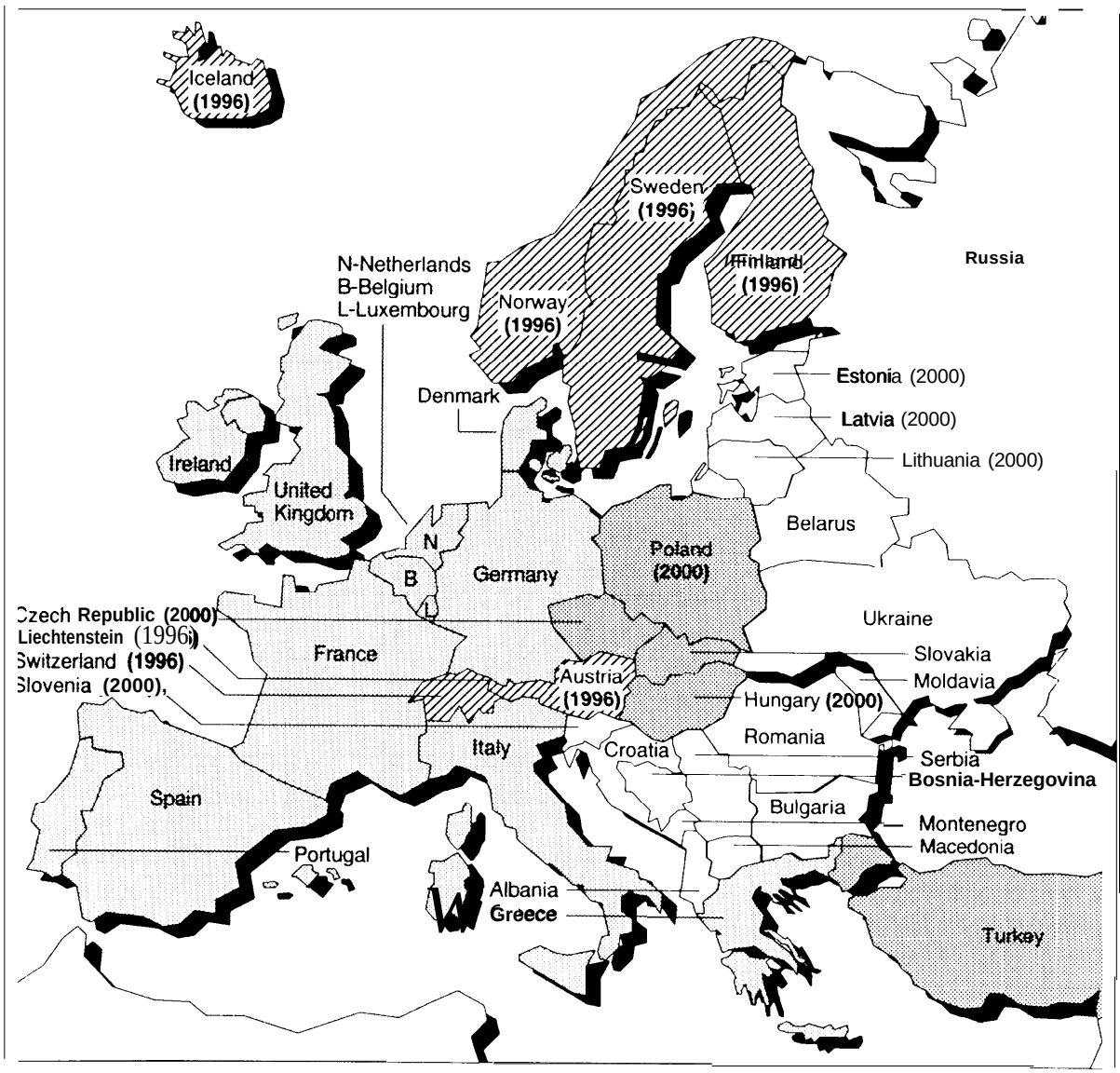
However, the failure of CITEL'S efforts at WARC-92 should not be considered a systemic failure of CITEL as a coordination mechanism. Rather, its ineffectiveness illustrates the need for better regional cooperation, both in conference preparation and at the conferences, and indicates that further work must be done if CITEL is to more forcefully represent the interests of its members. Most analysts do not believe, however, that the goal of efforts to improve CITEL should be to mirror the kind of organization represented by CEPT--namely, development and strict adherence to common regional proposals by all members. "Common proposals" carry with them

---

20 CITEL is an ongoing conference convened under the auspices of the Organization of American States. See OTA, *WARC-92*, op. cit., footnote 1 for a more in-depth discussion of CITEL, its historical development, and its WARC-92 preparations.

21 This approach differs from that of CEPT, which actually submitted ''European Common Proposals for the Work Of the Conference.' In contrast, the idea behind CITEL WARC-92 preparations was not for the CITEL countries to actually submit "common proposals' to which each country would adhere, but to develop common positions from which each country would develop and submit its own formal, individual proposals for WARC-92. See International Telecommunication Union, "European Common Proposals for the Work of the Conference, Parts I and II, " Document 20-E, Oct. 7, 1991.

**Figure 1-2--Current and Projected European Community Membership**




(1996), (2000) –Indicate projected dates countries may join the European Community

**SOURCE: Office of Technology Assessment, 1993.**

the potential loss of national sovereignty and could lead to the type of inflexibility many observers attributed to CEPT. Maintaining national flexibility in a framework of regional cooperation seems to be the consensus goal of those involved.

Continued improvement in CITEL's effectiveness will require the cooperative efforts of the U.S. private sector and the Federal Government, as well as the other member countries of CITEL. Representatives from all these groups recognize the need for better coordination, and individuals from several CITEL countries approached U.S. delegation members and observers to talk about ways to improve future efforts. A long-term commitment must be made to the CITEL process if the region is to effectively work together at future world radiocommunication conferences.

### OTHER REGIONAL BLOCKS

In addition to CEPT and CITEL, some delegates reported that the French- and English-speaking countries of Africa were more united than they had been at past conferences. They also showed a willingness to follow the leadership of Morocco on several issues, making Africa a powerful force in later stages of the conference. As further evidence of the increasing unity of the African continent, observers point to the development of a regional satellite system-RASCOM. Some analysts believe that the unifying force of a common satellite communications system may lead to a more coherent approach to meeting the communications needs of the continent, and could form the basis for future cooperative efforts among the countries of Africa in telecommunications development and policymaking.

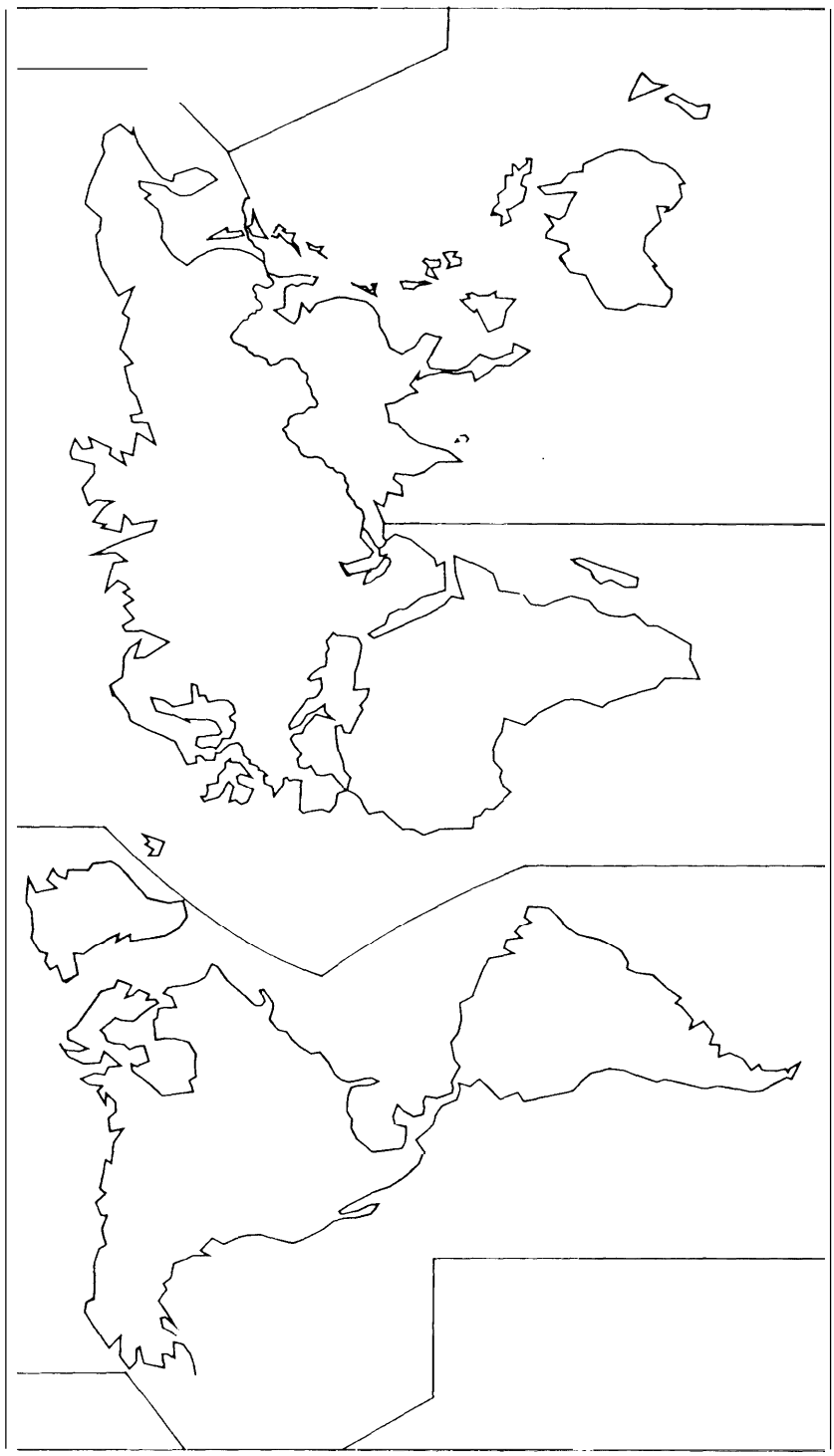
This coalescence could present the United States with an opportunity to improve relations with African nations and strengthen its negotiating positions internationally. Africa is part of the same ITU region (Region 1, see figure 1-3) as Europe. Improved ties and cooperation with Africa could provide leverage for U.S.-supported proposals. Other observers point out, however, that the African nations are still disorganized—they have nothing approaching the CEPT or even CITEL organizations, and are not yet a major market for telecommunications products or services.

The countries of the Asian Pacific represent another region of the world that is becoming increasingly important. While the region does not have an organization comparable to CEPT, the six countries of the Association of South East Asian Nations (ASEAN) have cooperated on trade issues in the past and have announced the formation of a free trade area that would include 320 million People.** And while not a member of ASEAN, Australia has been an active force at past conferences, including WARC-92. Japan has been quiet at past conferences, but has economic power that could come into play in the future. Although uniting all these countries in a single trading block is unlikely in the short term, they represent a huge market for U.S. goods and services, and could become powerful representatives of regional interests in ITU activities.

Because of these political/economic realignments and differences in the ways countries use spectrum, the United States has lost many important allies and some of the historical influence it has wielded in international radiocommunication policymaking. At past conferences, the United States had usually been able to count on the industrialized world and even, to a certain extent, on the USSR for support. By 1992, however, many of these historical ties had dissolved, and new ones were still being developed. As a result, at different points in the conference, the United States found itself isolated on several important issues. The Europeans, for example, opposed the United States on many items, including some of the most important issues of the conference-

22 ASEAN members include: Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, and Thailand. The ASEAN Free Trade Area (AFTA) is expected to begin Jan. 1, 1993. Paul Blustein, "Southeast Asia Joins the Bloc Party," *The Washington Post*, Nov. 10, 1992, p. B1.

**Figure 1-3—International Telecommunication Union Regions of the World**




SOURCE: U.S. Department of Commerce, National Telecommunications and Information Administration, *Tables of Frequency Allocations and Other Extracts From: Manual of Regulations and Procedures for Federal Radio Frequency Management*, September 1989 ed., p. 4-30.

future terrestrial mobile services, MSS, and BSS-Sound. The United States was also not able to develop significant worldwide support for its proposals on aeronautical public correspondence (APC) and HDTV.[23] The United States can no longer rely solely on its market power and technological preeminence to influence the outcomes of international radiocommunications conferences.

The rise of regional blocks of countries acting in concert at ITU forums presents the United States with both threats and opportunities. The threats stem from the possibility that U.S. proposals and positions could be overpowered in future WARCs. Conversely, the fluid state of alliances presents the United States with an important opportunity to encourage the formation of other blocks of countries, either on a regional basis or perhaps based on a particular special interest, that could support U.S. positions. The United States would not necessarily have to be an official member of such alternative alliances for them to prove useful. The development of alternate, competing power centers could be used to balance each other at future conferences. At the same time, the United States should cultivate alliances, both with members of the Western Hemisphere and with individual countries or other regional or international organizations that share U.S. concerns, in order to promote U.S. interests.

## The Economics and Politics of WARC-92

Economics and, as a consequence, politics are playing increasingly pivotal roles in the allocation of spectrum both internationally and domestically. In the past, international spectrum allocation was largely the province of government engineers, spectrum managers, and representatives from a few large (U. S.) telecommunications companies. Today, as the world's telecommunications industries and service providers are increasingly turned over to private ownership and as markets are opened to competition around the world, the economic stakes associated with spectrum policy are growing. Decisions that were once based primarily on technical considerations are now decided on the basis of economics (investments, revenues, and competitiveness) and politics as well as technology. As countries (or blocks of countries) have sought to advance their economic interests in radiocommunications, spectrum allocations have become a weapon in the battle for global economic supremacy, and WARCs, which decide how frequencies are to be divided between services, have become anew focus in the intense global struggle for competitive advantage in radiocommunication technologies and services. Countries seek to protect the interests and investments of their existing domestic users, and try to gain an advantage for their manufacturers and service providers in order to promote competitiveness.

*Economics and politics are playing increasingly pivotal roles in spectrum allocation—internationally and domestically.*

Evidence of the increasingly political aspect of the process is abundant. In the United States, companies or government agencies fighting for spectrum often raise the battles to the political level—pitting Congress against the FCC, and the Defense Department against the private sector. Congress, for example, got involved in the FCC's spectrum reserve proceeding in order to protect the interests of the incumbent users of frequencies the FCC proposed to reallocate. FCC commissioners have noted the political pressures and rumors surrounding the pioneer's preference pro-

23 In the case of APC, the United States held to its original position, protecting the systems already being used in the United States, Canada, and Mexico. However, in the case of HDTV, the United States went along with a compromise supported by other members of Region 2, the Western Hemisphere.

ceedings for LEOS services.[24] Motorola wrote then Vice-President Dan Quayle, seeking help in preventing the International Maritime Satellite Organization (Inmarsat) from entering the big LEOS arena (see chapter 2).

The consequences of this focus on economics and the consequential politicalization of WARCS have a number of effects clearly seen at W~C-92. First, despite the general belief that global allocations are the most advantageous-in terms of market size, consequential lower equipment costs, and reduction of interference-allocations were often made on a regional or even country-specific basis. Many countries, the United States included, inserted footnotes into the international Table of Frequency Allocations that prohibit services from operating in their country or allocate services that will operate only in their country.[25] Although such footnotes are sometimes necessary to protect important national services, fictionalization of the allocation table in this way makes it harder to share spectrum and coordinate services, and may lead to an increase in interference between different services operating in the same band in different countries. Divided allocations may also reduce the potential market for new services, increase equipment costs, and may even make some services (technically and/or economically) infeasible. The negative impacts of regionalization should not be overestimated, however. The large size of some regional markets may mean that a worldwide system or service would not convey any further significant economies of scale or size.

Second, in order to protect existing services, technical limitations were put on many of the new allocations. These include sharing requirements, power limitations, and stringent coordination procedures. Such limitations could severely limit the ability of a new service to operate and could preclude it altogether in some circumstances. At best, such limitations make the process of developing and introducing a new international radiocommunication service more difficult and subject to failure if countries cannot agree.

Third, long transition times were attached to some new services. In many cases, these services cannot come into operation for 10 or 15 years. These long transitions are designed to protect investments in equipment—allowing time for companies and countries to recover their investments before the systems are replaced. However, in an era of rapid technological change, when generations of technology are measured not in years, but in months, such a practice can also be used to allow lagging countries to ''catch up' to their competitors in the development of new technologies. In this role, long transition times are sometimes perceived as protectionist mechanisms of foreign trade policy.

For the future, the role of politics and economics must be clearly recognized and explicitly included in preparations and negotiation strategies. As the traditional role and power of foreign postal, telegraph, and telephone administrations (PTTs) erode, the locus of power will likely shift to private companies and government telecommunication ministries. The experience of WARC-92 showed the effectiveness of making direct contacts with high government officials in other countries. It is at these higher levels that political and economic pressures will be understood and acted on. Closer

---

24 Comments of Commissioner Ervin S. Duggan, "FCC Tentatively Chooses Non-profit Organization Proposing LEO Satellite Service to Aid Developing Country Volunteer Programs to Receive First Pioneer's Licensing Preference, ' *Telecommunications Reports*, Jan. 20, 1992. Comments of Commissioner James Quello at the August 5, 1992 meeting of the Federal Communications Commission.

25 Footnotes to the international Table of Frequency Allocations, just like the footnote you are reading, further describe or limit the allocations Listed in the table. They are designated by number and letter-731X (see figure 1-1, which shows a sample page from the international Table of Frequency Allocations, including how footnotes are presented). Footnotes are used for a variety of purposes, including to specify power levels, reference relevant resolutions, and allocate additional services. As noted, footnotes are also used by a country (or countries) to preserve some measure of national sovereignty when they disagree with the allocations that were made internationally. These country footnotes can make alternative or additional allocations or can limit operations within those countries.

cooperation with high-ranking foreign government officials may enhance the ability to achieve compromises acceptable to all sides.

## The Rise of the Private Sector

### INTERNATIONAL AND WARC ISSUES

As the forces of privatization and liberalization sweep through the world's telecommunication and radiocommunication industries, the number and influence of private sector interests and user groups are growing. This rise has the potential to alter the ways in which radiocommunication policies are determined internationally by bringing telecommunications system operators, manufacturers, and users more directly into the process. However, the increasing role of the private sector in international telecommunications regulation and negotiations may pose a threat to international structures and institutions such as the ITU. Historically, the ITU has been primarily an intergovernmental organization, bringing together the nations of the world in order to harmonize telecommunication and radiocommunication policies and coordinate international usage. With the rise of transnational telecommunication fins, however, and the demise of the government-controlled PTTs, control of the world's tele- and radiocommunications networks and policies is increasingly being influenced by the private sector.

As a result, the focus of world telecommunication and radiocommunication policymaking could shift. The structures and processes that were set up to accommodate intergovernmental negotiations may prove inadequate for private sector needs. Recognizing this, the ITU is attempting to open its activities more to the private sector. If its efforts succeed, it may survive as a new, more industry-oriented ITU. However, if its processes and structures begin to be seen by the private sector as too slow, or too political, or even irrelevant, some or all of the ITUs functions could increasingly be bypassed.

The rise of the translational corporation poses challenges to both domestic and international WARC preparations and negotiations, although the extent to which this is a serious problem is still unclear. Often such companies have branches or subsidiaries in many countries. In the preparations for world radiocommunication conferences, it is possible that representatives of these companies will pursue proposals that favor their home country or their company over best interests of the country in which they work. In the United States, with its open (FCC) preparation process, this is a serious concern. Foreign-based or foreign-owned companies doing business in the United States may seek to influence U.S. spectrum policy through their U.S. subsidiaries or partners in ways that favor *them* or their countries.[26]

*The private sector's rising influence is creating new threats and opportunities for United States spectrum policymakers.*

The multinational character of these companies is felt at the WARCs as well. In recent years, as the international trend to privatization and liberalization has advanced, more and more members of private companies have been serving on other nations' WARC delegations. This trend continued at WARC-92, and promises to accelerate in the future as ITU activities are increasingly opened to private sector participation. Some companies, in fact, may actually have representatives on several different delegations[27]—raising

26 In WARC-92 preparations, questions of foreign ownership and the influence that it might have on U.S. policymaking were raised in connection with two LEOS firms-Starsys, Inc., which has ties to the French Government, and I-oral, which is 49 percent owned by foreign companies (see chapter 2).

27 Motorola, for example, had representatives on several delegations, including the United States, Canada, France, and Australia.

the possibility at least that in international fora such as ITU conferences and meetings, these companies may (surreptitiously) choose to pursue strategies that protect or promote the company's best interests, but do not support and may actually undercut the efforts of the governments on whose delegations they serve.

## DOMESTIC ISSUES

The ramifications of this rise internationally are far-reaching, but the United States, with its active private sector and more democratic policy processes, could be affected more than other countries.[28] The role of the U.S. private sector in international telecommunication matters is unique in a foreign policy setting. Due to the historical development of the telecommunication industry in this country (private, not government-owned), and the high degree of expertise private sector representatives have developed in international radiocommunication matters, they play a much more active and involved role in foreign (telecommunication) policy than companies in other industries .29

During the preparations for WARC-92 and at the conference, for example, private sector representatives were very active in the development of U.S. proposals and in lobbying for U.S. positions at the conference. Generally, government and industry delegates believe these efforts were important in achieving positive outcomes for the United States. In the case of big and little LEOS, several delegates credited much of the success of the U.S. proposals to the work of the LEOS private sector proponents supported by the government. Ambassador Baran encouraged the wide participation of the U.S. private sector in order to demonstrate to foreign delegates that the United States was serious about its various proposals and that the proposals enjoyed broad industry backing.

The private sector will also be intimately involved in implementing the decisions of WARC-92. U.S. companies planning to operate in foreign countries, for example, will have to develop a knowledge base of the various stakeholders and regulations in those countries in order to negotiate for foreign licenses. The knowledge gained in this process could form an important foundation for planning and strategy as the United States prepares for future conferences.

The extensive involvement of the U.S. private sector in international radiocommunication policymaking has benefits and disadvantages. The primary benefits flow from the expertise industry representatives have developed. In many cases this experience was gained from previous service in the Federal Government. This relation fosters a closer sense of collegiality among Government and nongovernment representatives that promotes greater cooperation and better decisionmaking. In this way, the private sector supplements the government's own expertise, enabling the best and brightest of American radiocommunication experts to contribute to developing policies and positions.

The downside of this involvement is that private sector individuals represent the interests of their company, and in some cases, these interests may conflict with the greater interests of the United States.[30] On an individual level it is

---

28 Recognizing the importance of this restructuring for American companies, the State Department organized a private sector ITU Task Force to develop recommendations on how the United States should approach the special plenipotentiary. The final recommendations of this group were submitted to the State Department in December 1992.

29 In Europe especially, the telecommunications service providers have historically been public institutions—PTTs. In effect there were no private sector service providers, although manufacturers of equipment have been privately owned.

30 This is one reason conflict of interest disclosures were required from all U.S. delegates.

often difficult to balance the two. For official WARC delegates, this tension can be especially trying because delegates formally represent the United States, and they may have to support U.S. positions that they and their companies do not endorse and actively argued against in the past. Several delegates to WARC-92 reported feeling torn on various issues. In cases such as these, a danger exists that an individual may work more for his/her own interests and not support (or actually undermine) official U.S. positions. Isolated instances have occurred in past conferences, and infighting between the big LEOS proponents was evident at WARC-92, but, by and large, government representatives and delegation leaders report that the private sector delegates were relatively well-behaved at WARC-92.

More problematic is unofficial private sector involvement at the conferences. Past practice has allowed governments to let individuals from both the government and industry participate in the work of the conferences as ''observers' or ''support staff. At WARC-92, such designations were granted to a large number of people from the U.S. private sector. Again this practice has both good and bad effects. The primary advantage is that more people increases lobbying strength to support U.S. positions, gauge foreign delegates reactions, and simply get work done. WARC observers from both the government and the private sector credit a strong industry presence with helping U.S. positions get adopted. However, some delegates to WARC-92 (both U.S. and foreign) and others who attended WARC-92 have charged that lobbying was sometimes too aggressive or heavy-handed. Motorola, for example, had a contingent of representatives in Torremolinos estimated at over 30 people (all but one of whom was not part of the official delegation). Too large a group of "observers' can easily become overbearing and make foreign delegates feel dominated. In some cases, these industry representatives, who are not formal delegates and are less subject to formal control by the delegation leadership, can be overzealous-becoming, as one observer put it, "their own worst enemy. " Perhaps more than in the past, setting rules of conduct early in the process and maintaining tight control over the number and (to the extent possible) the actions of unofficial delegates will be important.

Participation by private sector companies also leads to questions of equity. Large corporations can afford to send sizable groups of their employees to international meetings such as a WARC. Smaller companies, however, have no such option. In many cases, they hire an outside consultant/ lawyer to represent them in the preparation work and at the conference. Disproportionate representation such as this may give an unfair advantage to those companies well-heeled enough to participate,

Finally, the direct and critical involvement of the private sector in sensitive international negotiations raises a number of important questions for U.S. policymakers. Fundamentally, who's in charge? At what point does the U.S. Government lose control of foreign policy? How much latitude should private sector delegates have at conferences? Should private companies take such an aggressive role? In such an environment, companies may feel free to cut "deals" with foreign countries in order to advance their own interests. In some cases, such arrangements may help further the policy objectives of the United States, but should such actions be condoned? In an era of translational corporations that owe less and less allegiance to any national government, there is no guarantee that private interests will always match U.S. public policy or foreign policy objectives. Aside from questions of legality, such actions could undercut the sovereign power of the U.S. Government to negotiate international agreements.

## IMPLICATIONS FOR U.S. POLICY AND TECHNOLOGY DEVELOPMENT

The lessons of WARC-92 and the implementation of its outcomes cannot be analyzed in isolation from the larger context of U.S. radiocommunication policymaking. That context is characterized by a divided government structure, a strong and involved private sector, and a philosophical commitment to market-driven policy development. The proposals that the United States adopted for WARC-92, and the manner in which the decisions made at the conference will be implemented domestically, are a product of these forces.

*The lessons of WARC-92 cannot be analyzed in isolation from the larger context of U. S. radiocommunication policymaking.*

OTA has previously analyzed the divided structure of U.S. radiocommunication policymaking and the problems that it causes in the WARC preparation process.[31] That analysis led to the conclusion that the fragmentation of U.S. radiocommunication policymaking, lacking clear long-term policy guidelines or vision, led to radiocommunication policies that were often reactive and lacking focus. And while this structure may have worked adequately for isolated issues or specifically-defmed topics such as WARC-92, it works less well for developing long-term and/or broader radiocommunication policy initiatives.

Looking beyond WARC-92, although senior policymakers increasingly recognize the importance of the international dimensions to radiocommunication policy and more effective planning, it is possible that philosophical, structural, procedural, and institutional inertia may inhibit creative policy development and prevent the United States from aggressively moving ahead in radio technology policy development. Even with a change in Administrations, which may bring more focused direction and leadership to U.S. radiocommunication policy development, structural and procedural problems will continue to exist, and ideological changes at the top levels of the government may take some time to falter down to career spectrum managers. Established institutional cultures and beliefs, and uncertainty over how much the spectrum can and should be planned, could make the implementation of any new vision difficult.

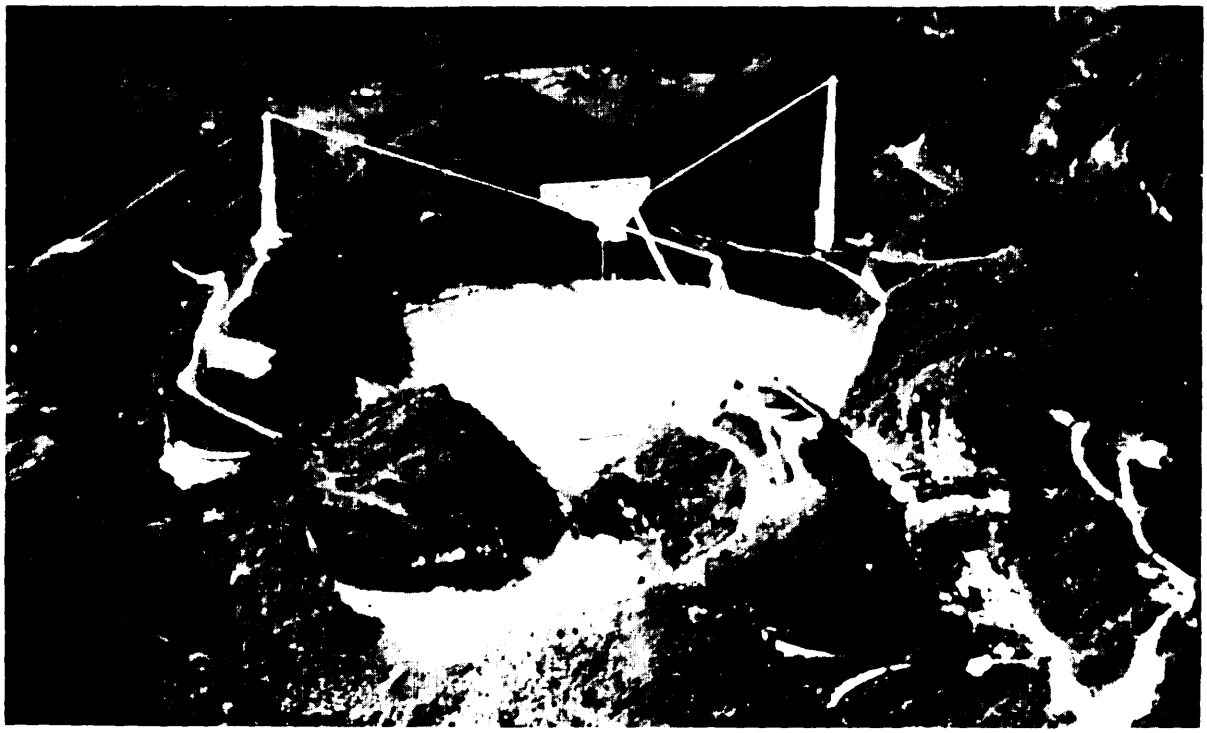
### Refining the Market Approach to Spectrum Policy

In place of focused forward-looking policy leadership by the Federal Government, the United States has relied almost solely on market forces to guide the development of radiocomrnunication services and technologies in this country .32 And while market mechanisms do have advantages in technology development, there are dangers in relying too heavily on such an approach. Overreliance on market mechanisms, combined with the divided nature of U.S. radio spectrum management and a lack of forward-looking action on the part of Federal policymakers, has led to a drift in international radiocommunication policy that could consign the United States to being a second-rate radiocommunication power.

Historically, the United States has based its approach to telecommunication development on a philosophical/ideological model that identifies "the market" as the best driver of technological

31 OTA, *WARC-92*, op. cit., footnote 1.

32 NTIA, op. cit., footnote 3.



National Science Foundation

*Radio astronomers use large dish-shaped antennas, such as this one in Puerto Rico, to help them explore the Universe. These antennas must often be several hundred feet in diameter in order to pull in the faintest radio waves from distant galaxies.*

progress.[33,34] According to this approach, market mechanisms provide maximum flexibility to industry to develop and sell products and services that meet consumer/user demands. Similarly, government spectrum managers believe that *a priori* planning of radiocommunication services would lead to inefficient use of the spectrum by committing frequencies to technologies and services that may not succeed in the long-run. Proponents of a market approach point to U.S. leadership in many areas of radiocommunication technology and the highly developed state of U.S. radiocommunication systems (compared with other countries) as proof that the market-based approach should be the preferred model for technology development.

### PROCESSES OF MARKET-BASED POLICYMAKING

In practice, the market model affects the development of radiocommunication policy on at least two levels. At the broadest level, the market is called on to determine what technologies and services should be developed, how much spectrum should be allocated to them, and in what bands. This approach to policymaking and spectrum allocation suffers from several flaws. First, the market can only sort effectively and effi-

33 For one view of the difference between market-driven and technology-driven approaches to telecommunications, see Barbara J. Farrah and D. Mike Maxwell, ''Market-Based Public Policy, ' Telephony, June 15, 1992 p. 80.

34 Not withstanding efforts by the FCC in the early 1970s to create spectrum reserves for land mobile technologies. For a brief history Of these actions, see Federal Communications Commission, In *the Matter of Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, 7* FCC Rcd No. 4, Feb. 7, 1992.

ciently between competing commercial uses, or uses that can be reduced to dollar figures. It cannot adequately judge between a commercial system, for example, and a radiocommunication service that serves larger social goods or goals, such as public diplomacy or radio astronomy—where few or no direct monetary benefits may accrue. In cases such as these, public policy must step in to fill the void left by a market approach. Policymakers must decide how to strike the balance between the important social functions filled by radiocommunications-public safety, defense, diplomacy, and scientific research-and (new) commercial systems that could potentially improve U.S. competitiveness in radiocommunications, create jobs, and improve our balance of trade.

Determining g the "public good' in this new era of wireless communication will be increasingly difficult. Many different players in the government and industry need the radio spectrum to carry out their missions and provide services to the public. Domestic policy battles over spectrum use will intensify as the Nation's airwaves become increasingly congested—pitting the private sector against the government, different domestic radio industries against each other, and various Federal Government users against each other. For example, the use of radio frequencies to provide safety and navigation services to maritime and aeronautical users is a vital public interest use of the spectrum, but it is not particularly glamorous. The importance of such uses can sometimes get lost in the enthusiasm for new consumer technologies. In these battles, the legitimate interests of the existing users of the spectrum must be balanced against the potential benefits to consumers and advantages to international competitiveness that new technologies could bring. Too often, as policy is determined now, such evaluations-based on a comprehensive assessment of the benefits and disadvantages of each competing user—are not made.

Second, what is "the market' and who defines it? Presumably the market is perceived user demand for a product or service. Unfortunately, this demand is usually measured and reported on by the very companies that wish to serve it—they have an obvious motive in making the proposed service seem as popular and desirable as possible. As a result, the marketing projections made by these potential providers may be overestimated. The widely varying estimates of the market for satellite-delivered phone services indicate the subjective nature of this approach. Allowing the private sector to dictate radiocommunication policy through its definition of market demand may skew the policy development process in ways that benefit companies at the expense of consumers or the long-term development of a coherent radiocommunication policy designed to serve public needs.[35]

Because of the difficulties in identifying "successful" technologies, opponents of greater Federal Government involvement in technology development (industrial policy) believe that the government should not be put in the position of picking specific technology winners" and 'losers. Rather, they argue that the government should support any and all radio-based technologies that contribute to an agreed-upon framework of policy goals for radiocommunications development. Such policy goals and objectives, however, like the concept of universal service in telephony, cannot be set or achieved by market forces alone.

Furthermore, some analysts, in fact, argue that the U.S. approach to telecommunication technol-

35 Some analysts are more blunt: ''The public has been largely shutout of the communications policy process. Although the Communications Act of 1934 mandates that all actions implementing it be based on determinations that they are in 'the public interest,' the FCC has viewed the public as nothing more than customers. It has let those who sell services to the public decide what is best for them." Nolan Bowie, Angela J. Campbell, and Andrew Jay Schwartzman, ''Telecommunications, '' in Mark Green, (cd.), *Changing America: Blueprints for the New Administration (New* York: Newmarket Press, 1993), pp. 604-615.

ogy development is often not market-, but technology-driven. "If you build it they will come" still seems to be the dominant theme in U.S. telecommunications technology development.

> Although the current [industry] language suggests a market model, the actions continue to focus on a technological one. This confusion has brought the industry to its present impasse. More than anything else, this impasse is characterized by effort after effort to develop ''market-driven" products, only to have the products repeatedly fail in market trials.
>
> Why is this happening? The industry has carefully identified products customers could use... The answer lies in understanding how paradigms affect actions. . . if their [companies'] vision is limited by a focus on technology, if their insight is bounded by a commitment to specific products, they may see only what technology can do for customers rather than learning what customers need technology to do for them.[36]

The reason for this continued reliance on technology has been attributed to the fact that "all too often, the people who invent and design new technologies are not the ones who debate and think through their social, economic, and policy implications. 37 In other words, technology is often developed by engineers who concentrate on solving technical problems, but give less thought to how (or even if) the technology systems they have developed will really be used. Given this historical focus, letting the market decide, when the market is defined by the companies trying to serve it, is not necessarily a sound basis for determining public policy or the public good. More specifically, in the development of WARC proposals, the dictates of an as-yet-unspecified market demand should not be uncritically accepted or given undue weight in the preparation process. Noncommercial systems that serve important public (safety) communication needs must be fairly considered and equally strongly advocated. Government regulators and analysts must play this role.

Some analysts have likened the change that needs to occur in telecommunications policy with the change in paradigm from an industrial economy to an information economy—with a change in focus from industry to public interest needs. Congress has an important role to play in moving U.S. telecommunication policymaking into the 21st century. Today, legislation is often

> . , . designed from art industrial age perspective to protect industrial age players. They represent sellouts to special interest groups rather than the responsible leadership needed in these economically turbulent times.[38]

*The dominant theme in U.S. telecommunications technology development still seems to be "if you build it they will come. "*

More forward-looking leadership from the Congress could push U.S. spectrum managers to consider more carefully the long-range impacts of their decisions on all of **American society,** and take a broader, more comprehensive approach to evaluating the public good.

The second means by which the market controls radiocommunication policy is just as important. Once a market decision has been made regarding which services are most needed, the market is then called on to sort out competing systems, standards, and companies. Unfortunately, the market is fickle, and acts according to

36 Barbara J. Farrah and D. Mike Maxwell, "Rethinking the Telecom Field of Dreams," *Telephony,* Mar. 9, 1992, *p.* 50.

37 D. Linda Garcia, remarks before the Annual Conference of the Public Radio Program Directors Association, Philadelphia% PA, Sept. 17, 1992.

38 Barbara J. Farrah and D. Mike Maxwell, op. cit., footnote 36.

economics-it does not necessarily take into account important social or political goals.

Finally, the market does not always work. In the standards-setting arena, there are many examples when market forces have failed, including AM stereo and digital cellular telephone.[39] In these cases, the failure of the market to quickly converge on a standard held up the development and deployment of the most advanced technologies. In an era of rapid technology developments, waiting for the market to set standards and sort out winners and losers could leave the United States behind its international competitors in advanced wireless applications.[40] During the preparations for WARC-92, for example, private sector stakeholders often complained about the lack of government leadership and guidance in developing positions.

*Relying solely on the market undermines effective strategic planning.*

### EFFECTS OF A MARKET-BASED APPROACH

From a policymaking perspective, U.S. reliance on market forces at both levels has several undesirable effects. First, there is a philosophical commitment in this country to the democratic ideal where proponents and opponents come together in a neutral forum to debate the merits of an idea and arrive at a reasoned conclusion or decision. This is a forum where information flows freely, and the technical merits of a technology should decide its fate-win or lose. However, in reality, the picture is more complicated. In cases where the economic stakes reach into the billions of dollars, companies will look for any means to discredit their competitors and politics often enters the equation (witness the political overtones to almost every major decision the FCC makes). If the market were a level playing field, all rivals could compete evenly. However, in this debate, all parties are not equal. Larger companies, with more resources and better political connections and clout, can often gain an 'unfair' advantage. As a result, the market is not allowed to function normally. It becomes hostage to the various political and legal machinations industries use to either protect themselves (as in the case of personal communication services) or to promote themselves (as in the case of LEOS). The market sometimes has less to do with deciding outcomes than the political considerations that have come to the fore with the rise of the (economic stakes of these) new technologies.

Relying solely on market forces to determine spectrum policy also undermines effective strategic planning and could decrease the long-term competitiveness of the United States in new radiocommunication services. Indicative of the lack of strategic focus in radiocommunication policymaking, no effective governmentwide mechanism exists for comparing and evaluating radio technologies and services as a basis for public policy decisions. The FCC, through its public comment processes, does try to make these kinds of analyses, but it only controls the private sector

39 The FCC has now been mandated t. set a standard for AM stereo. Telecommunications Authorization Act of 1992, Public Law 102-538, Oct. 27, 1992.

40 A nagging question from the WARC-92 preparations process, and one that tiers debate in the standards-setting arena for new technologies, is at what point should positions (and standards) be set. By waiting for the market to decide (determine a standard) the United States could lose any competitive advantage it might have. Waiting also makes it very difficult to push U.S. proposals and policies abroad, when they have not been set. Such disputes were highly evident in the preparation for the The Inter-American Telecommunications Conference (cITEL) WARC-92 preparation meeting held in Washington DC. Would the United States be better served by adopting a decision early and getting a potential jump on the competition? On the other hand, locking in a position too early could jeopardize effective negotiation-if U.S. representatives did not have the flexibility to modify their stances-just as setting a standard too early can lock in technology that is not the optimum. For a more complete discussion of the policy issues surrounding standards setting, see U.S. Congress, Office of Technology Assessment, *Global Standards: Building Blocks for theFucure, TCT-512* (Washington, DC: U.S. Government Printing Office, March 1992).

use of the spectrum. There is no open, effective way to compare government and nongovernment spectrum use. WARC-92 was, in large part, a struggle for spectrum between emerging wireless technologies and services and established radio frequency users. For several reasons—lack of objective sources, lack of FCC staff resources, pressures imposed by the shortness of WARC-92 preparation time, secrecy of government data, lack of experience and data on new services—open evaluations of the public interest benefits and/or disadvantages of competing radio services were never made.

The foremost example of this lack of process was the competition for the coveted frequencies in the L-band. The Federal Government and major aircraft manufacturers use the lower portion of this band (1435-1525 MHz) for aircraft and weapons testing. Because these activities are classified, however, the FCC claims it was unable to determine exactly how the government and its contractors use the band-i. e., what frequencies, what times of day, what geographic locations. The government was never forced to fully explain its use of the band.[41] The private sector, because of the favorable transmission characteristics of the band, wanted to use this spectrum for mobile satellite services or digital audio broadcasting satellite services. While a comparison was apparently made between the existing uses of the band and the potential revenues, technological gains, and competitive benefits that could be realized by reallocating the band for BSS-Sound, it is unknown what factors were used in the comparison or how they were valued.

Finally, the reliance on private industry to identify future spectrum needs obscures the second-order effects of new systems and services. Assuming frequencies are granted, what real benefits will the United States realize? Many of the new systems and services tout their benefits to American competitiveness. Such claims need to be examined closely. Will the equipment needed for these new services be produced in the United States? Indications are that some will not be. Little LEOS service providers, for example, report being disappointed with the response of U.S. manufacturers to this potentially lucrative new area. More importantly, for a system to succeed globally, it will need to attract support (and funding) from a variety of foreign sources, both government and private sector—global systems will require global partners to succeed. Launches may not be on American rockets, and much of the other equipment for the systems may not be produced in American factories. The real benefits to American competitiveness may come only in enhancing the U.S. reputation as the world's premier provider of satellite services, and laying the foundation for future advances in global satellite markets.

Overall, relying on the power of the U.S. radiocommunication market alone would be a mistake. The emerging markets of Europe and Asia will challenge U.S. claims to being the world's preeminent technology developer and consumer. Creative and aggressive policymaking, taking advantage of market forces, is needed to ensure the competitiveness and leadership of the United States in world radiocommunication markets. Without such leadership, the United States will continue to rely on its private sector to set the direction for U.S. radiocommunication policy. Industry, however, needs the guidance and partnership of

*Creative and aggressive policymaking is needed to ensure United States competitiveness in world radiocommunication markets.*

41 Government spectrum managers dispute this view. They contend that they made all *necessary* information available to the FCC for review. However, what information was actually provided, its accuracy and completeness, is unclear.

government planners to make the United States a strong, coherent presence in international radiocommunication policymaking and markets. A more aggressive policy process is needed to bring leadership, direction, and coherence to U.S. international radiocommunication policymaking.

## Improvements in Long-Range Planning

As a result of the historical reliance on market forces and the lack of Federal Government leadership in spectrum policy development, long-term planning for future uses of the radio frequency spectrum and coordination of spectrum policy (including priority-setting) are inadequate. For example, although U.S. proposals for WARC-92 were developed in a timely fashion, it is less clear how well, if at all, these proposals (and the policy directions they imply) fit into long-range policy goals or even if such long-range goals have been considered. Preparing WARC proposals and positions is not equivalent to developing long-term policy (even if WARC negotiating strategies are carried out over long periods of time), and it is unclear if such an essentially ad hoc approach can meet long-term needs. A more regular ITU schedule for future conferences will increase pressures to develop more coherent U.S. policymaking initiatives, and force both the government and the private sector to consider long-term goals in a more clearly defined and focused way.[42]

*Long-term radio frequency spectrum planning* and *coordination of spectrum policies are inadequate.*

OTA has argued in the past that a reliance on market forces and a lack of government and private sector foresight in planning for future radiocommunication services will hurt the U.S. ability to compete internationally .[43] OTA continues to believe that between a purely market-based approach to spectrum management and an overly centralized approach to planning, there is a middle ground of creative, aggressive planning and policymaking that will enable the United States to compete more effectively in the new technologies and services that are being developed.[44]

However, developing a practical approach to spectrum planning will be challenging. A number of analysts in both the government and the private sector have noted the difficulties in planning spectrum. First, planning for needs and technologies that do not yet exist is nearly impossible, and would not necessarily lead to efficient use of" the spectrum. The tradeoffs between encouraging efficiency and promoting the development of new technologies must be carefully weighed as a part of determining future radiocommunication policy. It may be possible to craft policies and regulatory efforts that encourage both, but it will be necessary to carefully balance the needs for efficiency with the demand for new technologies and services. Second, even if spectrum is more concretely planned, this does not guarantee that a market for the planned service will actually develop or that the services/systems planned will become economically viable. The 12-GHz band of frequencies, for example, has been planned for several years to provide direct broadcast televi-

42 NTIA has taken steps in this direction with its proceeding on future spectrum requirements, as has the State Department with its task force on U.S. reactions to changes in ITU. See U.S. Department of Commerce, National Telecommunications and Information Administration, ''Current and Future Requirements for the Use of Radio Frequencies in the United States," Notice of Inquiry, Docket 920532-2132, June 1, 1992.

43 OTA, *WARC-92*, op. cit., footnote 1.

44 A similar concept has been called a "progressive" approach to telecommunications regulation. See Steven R. Rivkin and Jeremy D. Rosner, "Shortcut to the Information Superhighway: A Progressive Plan to Speed the Telecommunications Revolution" *Future Choices,* August 1992.

sion services from satellites. Despite the fact that such services were frost proposed in the early 1980s, they are only now beginning to be implemented, and their eventual success is far from certain.

One of the fundamental reasons for the lack of a clearly defined vision/framework to guide U.S. radiocommunication policy development is the divided responsibility for policymaking in the United States. The FCC and NTIA have not worked cooperatively to build such a view or framework. Recognizing these problems and the importance of radiocommunications, in recent years U.S. policymakers at higher levels have begun to pay greater attention to spectrum policymaking.

The executive branch has taken the lead in revitalizing spectrum planning. NTIA recently issued a Notice of Inquiry requesting comments and information on ''Current and Future Requirements for the Use of Radio Frequencies in the United States, ''[45] In the Notice, NTIA notes clearly the importance of improved planning of the spectrum resource:

> . . . planning helps ensure that adequate spectrum will continue to be available for public safety needs, other non-commercial uses such as amateur radio and scientific research, and local, state, and federal government uses, Moreover, improved planning is essential for the U.S. government to represent effectively the interests of all U.S. spectrum users in international spectrum negotiations. Such planning is especially important to permit the presentation of consistent policies in such forums as the new series of biennial World Administrative Radio Conferences recommended by the High Level Committee of the International Telecommunication Union (m).

In its comments on NTIA's proceeding, Motorola notes further that ''this explosive growth of new mobile communications services, driven by technological advances and consumer demand, will lead to a serious shortage of spectrum absent sound spectrum planning. ''[46]

Unfortunately, these efforts have not yet been matched by the FCC. Critics accuse the Commission of doing little more than reacting to technology developments. It responds to applications and petitions, but has shown a notable lack of aggressiveness or foresight in helping to advance the development of radio technologies. Numerous observers have commented that the FCC will not act until someone forces it to by filing a petition for change. Despite a historical lack of planning at the FCC, however, there are signs that things could be different. The FCC has taken an aggressive (ironically, some say too aggressive) approach to developing standards and an implementation schedule for HDTV. The FCC's Office of Plans and Policies has written studies on the future of fiber optics and the broadcasting industry.[47] In early 1992, the FCC proposed the creation of a ''spectrum reserve in order to promote the development of new radiocommunication technologies and services.[48] Aside from the political problems encountered by the plan, the FCC's efforts at least represent an effort to spur future development.

In terms of international spectrum planning and policymaking, the National Aeronautics and Space Administration (NASA) and the international Space Frequency Coordination Group (SFCG)

---

45 NTIA, op. cit., footnote 3.

46 Comments of Motorola, Inc., in the matter of ''Current and Future Requirements for the Use of Radio Frequencies in the United States, X," op. cit., footnote 34, p. 4.

47 Robert M. Pepper, *Through the Looking Glass: Integrated Broadband Networks, Regulatory Policy and Institutional Change* (Washington DC: Federal Communications Commission, November 1988); Florence Setzer and Jonathan Levy, *Broadcast Television in a Multichannel Marketplace* (Washington, DC: Federal Communications Commission, April 1991).

48 Federal Communications Commission, ''R~~elopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, " *Notice of Proposed Rulemaking*, ET Docket 92-9, 7 FCC Rcd No. 4, Feb. 7, 1992.

may provide a model of planning for future spectrum needs. The SFCG (see chapter 2) is composed of space agencies from all over the world. This group identifies the future needs of space operations and research, and develops consensus among member countries, on a continual basis, on how best to meet those needs. Because of the long lead times to get large-scale space operations and missions into space, this group has to think of their spectrum requirements in the long term and then develop international agreements to get what they need. In the United States, for example, NASA was a strong driver pushing the United States to become more involved with and to support what turned out to be WARC-92. As a result of the extensive pre-negotiation done in the SFCG prior to WARC-92, new allocations for space services were relatively easy to agree to at the conference.

*Despite the increasing importance of telecommunications in world and domestic economies, no action has been taken to unify United States telecommunications policy.*

## The Future: Protecting US. Technological and Policy Leadership

As the United States moves into the 21st century and wireless technologies and services become an increasingly important part of the overall telecommunications infrastructure of this country, the timely development of appropriate radiocommunication policies, both domestic and international, becomes imperative. Many analysts have identified the general problems and shortcomings of the presently divided structure of U.S. telecommunications policymaking.[49] As a subset of overall telecommunications policy, spectrum planning and management suffers from the same problems. It is important to note, however, that despite the increasing importance of telecommunications in world and domestic economies and the strategic and competitive benefits a strong telecommunications policy represents, no action has been taken to unify U.S. telecommunications policy, although some efforts have been made to improve long-term spectrum management.

The large number of radiocommunication technologies and services now being developed, and the corresponding increase in the number and influence of private sector interests, will place increased emphasis on government and private sector cooperation to prepare for future world radiocommunication conferences, to carry out cooperatively developed strategies at the conferences, and to implement new domestic radiocommunication rules and regulations. There is a significant amount of expertise in both the government and the private sector that must be tapped in creative ways to bring the benefits of new technologies and services to American consumers and to promote the competitive interests of U.S. radiocommunication firms overseas.

Unfortunately, the United States has had no vision or policy framework that could guide spectrum development and that would ensure that the spectrum resource is utilized in the public interest and for the benefit of the Nation. Overall,

49 For a discussion of such issues, see Henry Geller, *The Federal Structure for Telecommunications Policy* (Washington, DC: The Benton Foundation 1989); U.S. Congress, Office of Technology Assessment, *Critical Connections: Communications for the Future,* OTA-CIT-407 (Washington DC: U.S. Government Printing Office, January 1990); U.S. Congress, Office of Technology Assessment, *The 1992 World Administrative Radio Conference: Issues for U.S. International Spectrum Policy, OTA-BP-TCT-76* (Washington, DC: U.S. Government Printing Office, November 1991); Michael F. Starr and David J. Atkin, "The Department of Communications: A Plan and Policy for the Abolition of the Federal Communications Commission, " *Hastings Communications and Entertainment Law Journal,* vol. 12, No. 2, titer 1989; and U.S. Department of Commerce, National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future,* NTIA *Special* Publication 91-23 (Washington, DC: U.S. Government Printing Office, February 1991).

the process of developing coordinated domestic and international radiocommunication policy in the United States is seriously lacking. Decisions and policies are often reactive and not based on long-term considerations. This situation is compounded by the fact that there has not been one decisionmaking authority that effectively arbitrated policy disputes between Federal agencies in a timely manner; that made policy-level decisions among competing agency missions and requirements.[50] The recent change in Administrations may bring more focus and vision to U.S. spectrum policy, but in any case, it is too soon to gauge the impact anew perspective could have on improving U.S. radiocommunication policymaking, or the effectiveness of such an approach in the face of stubborn institutional and structural barriers.

The trends examined above and the issues and implications outlined in chapter 2 demonstrate the need for a comprehensive approach to spectrum management in this country, and the potential consequences to services and competitiveness if such a policy framework is not adopted. Unless institutional and structural changes are made, this lack of policy guidance and planning will, in the long term, reduce the U.S. leadership role in international radiocommunication policymaking and could erode the U.S. competitive position in radio-based technologies and services.

## OPTIONS FOR IMPROVING U.S. POLICYMAKING

The choices for improving domestic and international U.S. radiocommunications policymaking cover a broad range of approaches and options. Many of the options discussed include reorganizing the institutions and processes by which international spectrum policy is made. Any successful reorganization, however, must be based on *specific* public policy goals that the reorganization is designed to achieve.[51] A careful analysis must also be made of the tradeoffs of reorganization, including those between efficiency, equity, and political and public accountability.[52] Reorganizations based on well-meaning, but elusive concepts—such as improved economy, efficiency, or public responsiveness—are not likely to be successful in the absence of clearly defined goals.

*No single decisionmaking authority has effectively arbitrated policy disputes between Federal agencies in a timely manner.*

At the broadest level of policy development, presidential leadership may be effective for set-

m The director of the Office of Management and Budget (OMB) is authorized to resolve appeals between agencies over specific Federal Government frequency assignments, but this authority does not appear to extend to policy decisions or give OMB the right to decide matters of policy such as which agency mission(s) should take precedence over others in matters of frequency allocation.

51 In a 1977 report t. the Congress, the Congressional Research Service noted that: ''Reorganization itself cannot be a 'value. ' It receives its normative content by absorption. A reorganization is 'good' or 'bad' depending upon the purposes the reorganization is **designed to achieve.** Presumably, in the hierarchy of purposes, a reorganization should be justified on the grounds that it is facilitating the achievement of a 'higher purpose' than that which is the purpose of the current organizational structure. It is the task of President Carter, as it was of his predecessors and will be of his successors, to develop a hierarchy of values so that the process of reorganization with be neither random nor counterproductive, but will serve a purpose which is both consistent and visible. Ronald C. Moe, *Executive Branch Reorganization: An Overview*, prepared by the Congressional Research Service for the Committee on Governmental Affairs, U.S. Senate, committee print, March 1978, p. CRS-72. The relationship of goals to institutional organization is also discussed in U.S. Congress, Office of Technology Assessment, *Critical Connections; Communication for the Future*, OTA-CIT-407 (Washington, DC: U.S. Government Printing Office, January 1990).

52 Craig Thomas, "Reorganizing Public Organizations: Alternatives, Objectives, and Evidence, ' paper prepared for the Secretary of Energy Advisory Board, U.S. Department of Energy, August 1992. This paper also notes the necessity of choosing between goals ("values") "when deciding whether and how to reorganize a public organization,' and notes the ''profoundly political" nature of such decisions, p. 51.

ting the general goals and policy framework that will guide future radiocommunication policy. Likewise, Administration initiatives may also be able to improve specific aspects of the U.S. radiocommunication policy process—through executive orders, for example. However, forceful congressional action may also be needed to help focus attention on the broad problems facing U.S. spectrum managers and to develop priorities for resolving those problems. The approaches and options presented below give Congress a number of ways to work with the Administration in order to bring about desired improvements or to exercise more prominent leadership if the Administration fails to act quickly and decisively in improving U.S. radiocommunication policy structures and processes.

Depending on congressional interest and involvement, three basic approaches are available to reform the international radiocommunication policy process, within which specific options are presented. The three approaches represent a progression from least to most complicated—from short term solutions that could be implemented in less than a year, through solutions that could be developed over a 1 to 2 year span, and finally to more long-term, systemic solutions, which could take many years to enact. Each approach has its own benefits and disadvantages as outlined below. The options presented are not meant to be exhaustive or exclusive, and many different combinations of options are possible. Figure 1-4 summarizes these approaches and options, and figure 1-5 puts them in the context of Congressional decisionmaking.

## Approach 1

Improvements in the U.S. policymaking process must be made immediately to allow the United States to most effectively respond and adapt to rapid changes in radio technology and the recent restructuring of the ITU. Over the course of the next year, Congress could take several steps to improve the U.S. radiocommunication policy process in general and the WARC preparation process specifically. Congressional action, by targeting funding and focusing attention on key aspects of the U.S. spectrum policymaking process, would demonstrate commitment to and leadership of U.S. radiocommunication policy, and could encourage the development of more focused policies by the agencies involved. Such efforts could be made in concert with executive branch efforts or in place of them if insufficient interest or attention is forthcoming from the White House. Implementation of these options may also serve as a stimulus for further presidential action.

The first general approach would leave the existing three-part radiocommunication policy structure and procedures intact, and allow the FCC, NTIA, and State Department, as well as the individual Federal agencies, to build on improvements they have already instituted. The FCC, for example, established the Office of International Communications (OIC) in January 1990 to coordinate international policies. Driven by the increasing importance of international concerns in the FCC's daily work, and supported by former Chairman Alfred Sikes, OIC has evolved into an important center of policy coordination in the FCC. Most of the experienced international staff, however, still remain scattered among the FCC's various bureaus. As noted above, the State Department has convened a task force to examine changes in ITU structure and possible U.S. responses. NTIA is engaged in a long-term effort to improve its spectrum management procedures vis-a-vis the private sector,[53]

[53] The blueprint for these activities was first outlined by NTIA in early 1991, and many of the changes they identified have been put into place. U.S. Department of Commerce, National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: An Agenda for the Future*, NTIA Special Publication 91-23 (Washington DC: U.S. Government Printing Office, February 1991).

and has begun a broad assessment of the long-term spectrum needs of the United States.[54]

OPTION 1. *Take no action, but closely monitor the efforts noted above and the overall direction and development of U.S. international radiocommunication policy.*

OPTION 2. *Increase funding for existing agencies and programs and tie it to improvements in the radiocommunication policymaking process and/or WARC preparation activities.*

Targeted financial support for WARC preparation and spectrum policy planning activities could encourage more forward-looking policies and enable more thorough policy planning and technical preparation for future radiocommunication conferences.

OPTION 3. *Mandate the formulation of a long-range spectrum plan.*

If Congress believes that the executive branch is not making sufficient progress toward developing a more comprehensive and focused approach to international spectrum management, it could also require long-range and strategic planning on the part of all Federal agencies. This would force the executive branch to develop priorities for radiocommunication policy, and would also contribute to the development of a broader spectrum policy framework that would guide future policymaking efforts.

As the focal point of this effort, the FCC and NTIA could be required to cooperate on developing a long-range plan that would address the Nation's spectrum needs, with revisions to the plan submitted at regular intervals. In 1978, Executive Order 12,046 required that such a plan be developed, and although NTIA has produced a series of long-range plans beginning in 1986, these plans have largely been developed without the cooperation of the FCC (as required) and even at times without the participation of the Interdepartment Radio Advisory Committee(IRAC).[55][56] In the recent legislation statutorily authorizing NTIA, such a plan was listed as a function of NTIA, but was not mandated.[57] Making the development of such a plan a required responsibility of NTIA, subject to congressional review, could hasten the development of more focused policy.

This option would build on NTIA's current efforts to identify long-range spectrum needs, and expand this activity to serve as the basis for the development of a future integrated national spectrum plan. In order to bring the FCC more directly into the process (and meeting the original language of Executive Order 12,046), legislative language could be inserted in FCC appropriations to mandate formal FCC cooperation with the NTIA effort. The effort could also be further expanded to include all Federal Government agencies with radio operations. In some cases, such efforts may require the commitment of additional resources, but such increases could be minimal.

In order to accommodate the concerns of the private sector, another possible vehicle for improving the development of radiocommunication policy and new radiocommunication technologies and services is to fund (jointly with industry, perhaps) a radiocommunication equivalent of Sematech. In that case, the Federal Government funds a consortium of computer chipmakers to promote research and development of chips and promote U.S. competitiveness in the chip industry. A similar arrangement for radiocommunication could have a variety of missions. It could serve as a focal point for the development of radio

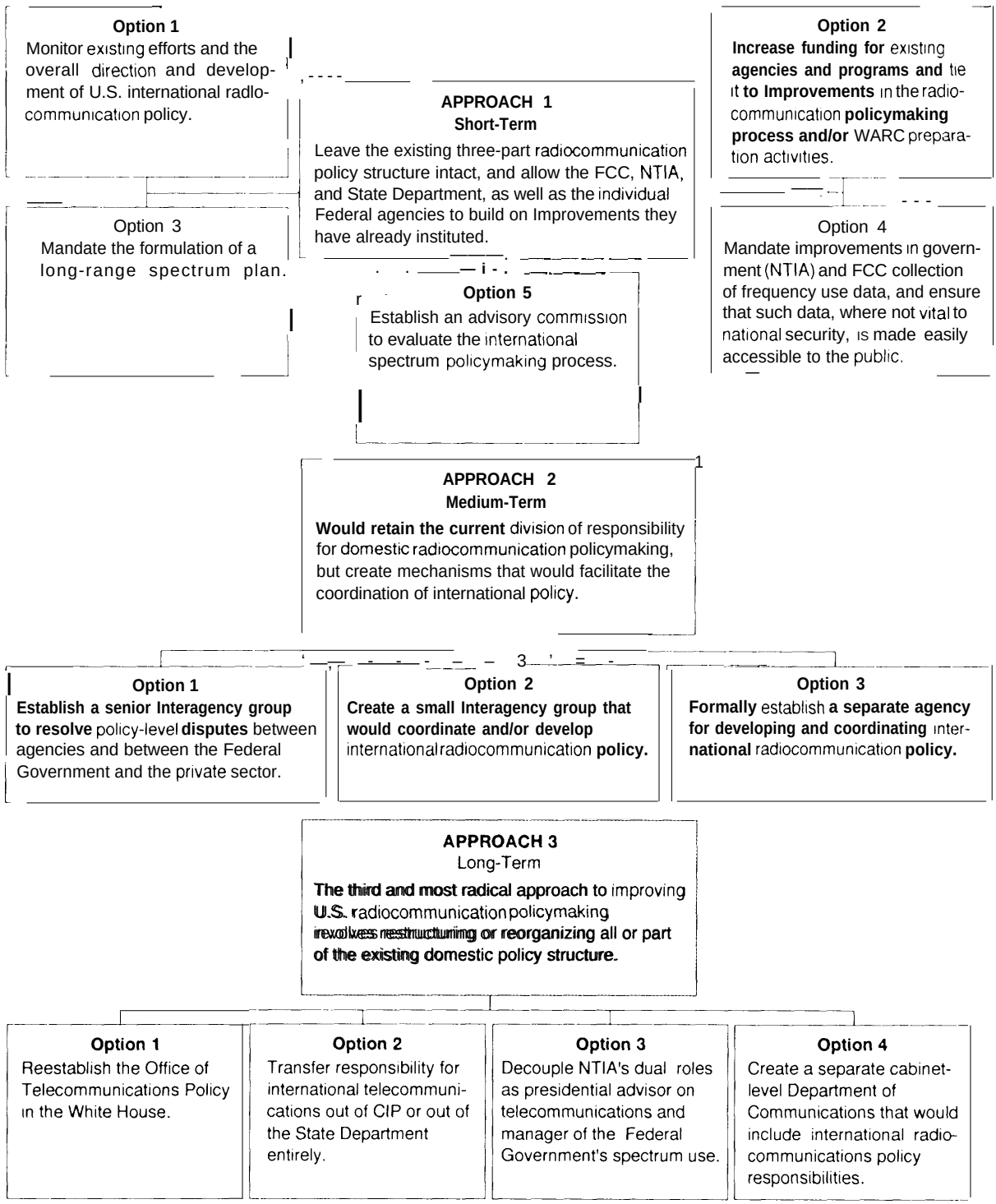
54 NTIA, op. cit., footnote 3.

55 Executive order No. 12,046, reprinted in 1978 U.S. Code Congressional & Administrative News, 9685-9692.

56 NTIA, op. cit., footnote 53, p.176.

57 Public Law 102-538, Oct. 27, 1992.

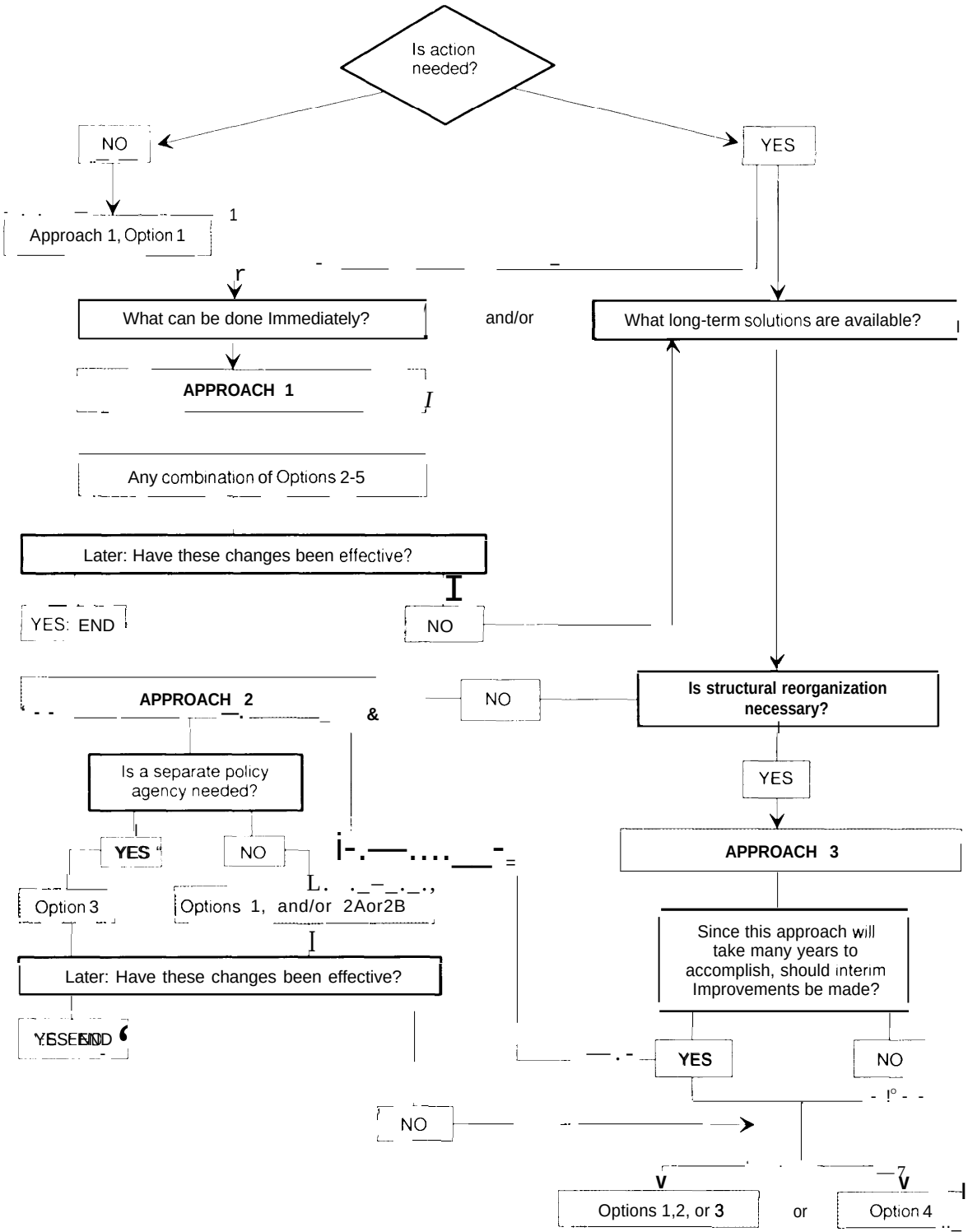
**Figure 1-4—Approaches and Options for Improving U.S. Radiocommunications** Policy




**KEY: CIP = Bureau of International Communications and Information Policy; FCC = Federal Communications Commission; NTIA = National Telecommunications and Information Administration.**

**SOURCE: Office of Technology Assessment, 1993.**

**Figure 1-5-Decisions to Improve U.S. Spectrum Policymaking**




SOURCE: Office of Technology Assessment, 1993.

technologies, focus private sector input into the radiocommunication policy process, and provide a forum for cooperative industry/government policy development. Such an organization could also serve as a clearinghouse for future world radiocommunication conference preparations.

OPTION 4. *Mandate improvements in government and FCC collection of frequency use data, and ensure that such data, where not vital to national security, are made easily accessible to the public.*[58]

Additionally, such data should be required to be shared with relevant policymaking authorities in order to reach informed decisions about future WARC proposals and spectrum requirements. In several cases during the preparation for WARC-92, private sector and even some government interests complained that they could not assess some uses of particular spectrum bands because the data either did not exist or were withheld.

**OPTION 5.** *Establish an advisory commission to evaluate the international spectrum policymaking process.*

Such a commission could be mandated to identify any problems with the current U.S. policy structure, recognizing the current state of flux in the world's telecommunications community, and to recommend specific improvements (if needed) in the structure and/or processes of U.S. international spectrum policymaking. Such a commission could be established in a number of different ways. Congress, for example, could pass legislation to establish such a committee, with membership to include individuals chosen by the President and assuring adequate representation for Congress.[59] The principle advantage of such a commission would be to focus more high-level attention on the processes of radiocommunication policymaking and encourage greater congressional and Administration (oversight of and) involvement in goal-setting for U.S. international spectrum policy. Another recent suggestion calls on the president to establish a commission to review overall U.S. communications policy and make recommendations for updating it.[60]

The advantages and disadvantages of essentially preserving the status quo mean continued reliance on market mechanisms to make broad policy decisions. This approach maintains an ideological commitment to market-based decisionmaking and ensures that the private sector has maximum flexibility to quickly respond to both new consumer demands and advances in technology. However, as noted previously, too much reliance on market forces reduces the amount and quality of strategic planning that can be accomplished. In the face of increasingly fierce competition in global radiocommunications systems and services from both Europe and Japan, such a policy may inhibit U.S. ability to compete effectively in world markets.

## Approach 2

Although the options presented above could contribute to the short-term improvement of the development of U.S. international spectrum policy, more substantial changes may be required to ensure that U.S. policies adequately reflect the technological, economic, and political changes now taking place in global radiocommunications policymaking. Over the next year or two, Con-

58 NTIA discusses options to improve access to frequency data in NTIA, *U.S. Spectrum Management Policy*, op. cit., footnote 53.

59 In 1966, for example, Congress passed the "Marine Resources and Engineering Development Act," which directed the President to establish a Commission on Marine Science, Engineering, and Resources. That commission had 15 members, limited to 5 from the Federal Government, and with Four members of Congress seining as advisors. The legislation specified the duties of the commission and provided for funding of its efforts. 'The committee was part of a broader legislative approach to develop a "comprehensive, long-range, and coordinated program in marine science. . . ." Public Law 89-454, June 17, 1966.

60 "Breaux Awaiting Reaction to Suggestion of Presidential Commission On Communications," *Telecommunications Reports,* Dec. 14, 1992.

gress may want to consider additional procedural and/or structural improvements that could improve U.S. WARC preparations and the overall policy development process. These medium-term options represent the next step in a broader evaluation of the efficacy of current U.S. methods for determining international spectrum policy.

The context and timing of these changes is crucially important. With world radiocommunication conferences scheduled to take place biennially, the distinctions between general policy development and WARC preparation will become increasingly blurred and will, in fact, begin to converge. A single focal point for integrating these trends would help the United States to develop and maintain a clear policy direction throughout all its international radio negotiations and meetings. NTIA, for example, proposed a Joint Strategic Planning Council, which would bring together the FCC and NTIA to coordinate domestic spectrum management policies,[61] An important factor in forming such a group is to get high-level support for its activities, and to ensure the active and effective participation of private sector interests.

The second approach to improving radiocommunication policy development would retain the current division of responsibility for domestic radiocommunication policymaking, but create mechanisms that would facilitate the coordination and/or development of international policy. Under this general approach, several options for improving the coordination and quality of radiocommunication policy exist.

OPTION 1. *Establish a senior interagency group that could resolve policy-level disputes between agencies and between the Federal Government and the private sector.*

A possible model is the Senior Interagency Group for telecommunications that was disbanded for budgetary reasons in the mid-1980s.[62] This group would have the power to review the spectrum uses of the various Federal agencies and prioritize the agencies' missions and future spectrum requirements. The group would also settle disputes between industry and the Federal Government regarding conflicting proposals for spectrum use. In order to fairly represent all interests, private sector membership in this group, as observers at least, maybe required. Efforts would have to be made to ensure the widest possible participation from industry-not just the largest or most well-established players.

OPTION 2. *Create a small interagency group that would coordinate WARC and/or international radiocommunication policy.*

This group could effectively complement the Senior Interagency Group noted in Option 1, and could probably be put together with a minimum of additional funds, although this would require further study. This solution was suggested by a number of delegates and observers, and took several different forms.

Option 2A. In its least complicated form such a group would coordinate, but not subsume, the activities of the FCC, NTIA, and the State Department in preparation for world radiocommunication conferences. This group would focus only on WARC preparation.

Option 2B. In order to ensure that WARC proposals effectively reflect broader U.S. international spectrum goals, the mandate of the group discussed in Option 2A could be broadened to include coordination not only of WARC positions and proposals, but also the coordination of all of international radiocommunication policy and integrating WARC preparations within an overall policy framework.

Legislation, for example, could create (reestablish) the Joint Long-Range Planning commit-

61 NTIA, op. cit., footnote 53.

62 For further discussion of past efforts to integrate spectrum policy, see OTA, *WARC-92*.

tee, composed of representatives of both the FCC and NTIA, that would meet on a regular basis, and produce a report to Congress every year or two years. This legislation would force the United States to specifically develop goals and plans for developing the radio spectrum resource and radiocommunication systems, and could provide a vehicle for Congress to participate in the goal-setting for radiocommunications and to closely monitor progress toward those goals.

OPTION 3. *Formally establish a separate agency for developing and coordinating international radiocommunication policy.*

Essentially, the international radiocommunication functions and staff of the FCC, NTIA and Bureau of International Communications and Information Policy (CIP) would be merged in one *agency.*[63] *Domestic* functions could be left intact. Such an agency would combine technical and policy expertise and, proponents believe, would effectively unify U.S. international radiocommunications policymaking and streamline both the development of policy and the WARC preparation process. Such a singular focal point for international radio policy could also improve the conduct of radiocommunications negotiations internationally. For example, foreign spectrum managers would no longer be confused by the three-part division of responsibility in this country and could no longer take advantage of this split to further their own positions. However, such a centralized approach faces opposition by many **analysts** and would be difficult to institute both institutionally and politically.[64]

The most difficult question regarding the establishment of such an agency is whereto locate it in the structure of the U.S. Government. Care would have to be taken to establish it at a high enough level to give it the authority to set priorities and policies, while at the same time avoiding the ability of one group or groups to dominate the agency's work. Clear lines of responsibility and coordination between this agency and the FCC, NTIA, and State Department would have to be established.

Along these lines, some have suggested the creation of an office similar to the U.S. Trade Representative (USTR) for international telecommunications (or just radiocommunications) policy. In 1962, Congress created a position in the White House for a special representative for trade negotiations, changed as the chief representative of the United States in all trade agreements negotiations, and chair of an interagency organization, established by the President, to assist with the implementation of trade and tariff agreements.[65] Paralleling the language describing the mission of NTIA, the USTR is designated as the President's "principal advisor" on international trade policy. The USTR also coordinates interagency preparation for and participation in multilateral trade talks, and supervises a network of private sector advisory groups.

The advantage of this option is that it would raise the level of international telecommunica-

---

63 For example, the agency would combine the FCC'S Office of International Communications, NTIA's Office of International Affairs, and the State Department's CIP.

64 The idea of centralizing telecommunications and radiocommunications policy in the United States has been discussed extensively elsewhere. For a brief review of the arguments for and against such an approach, see OTA, *WARC-92.*

65 The office supporting the USTR was created by executive order in 1%3. For a fuller discussion of the USTR, see Stephen D. Cohen, *The Making of United States International Economic Policy,* 3rd Ed. (New York: Praeger, 1988). Cohen reports that the creation of the office was precipitated by Congressional doubts about 'the State Department's ability to drive a hard bargain and bring home the most advantageous trade agreement. . ." (p. 66). Similar concerns have been raised about the ability and will of the State Department to negotiate international telecommunication agreements-some believe that they are more concerned with keeping foreign governments happy than anything else. The 1974 Trade Act elevated the position to cabinet-level status. In 1980, under Reorganization Plan No. 3, the office was renamed the Office of the USTR and received a broader mandate that effectively made the office "the lead agency in all aspects of policy formulation in the trade and investment sectors. Reorganization Plan No. 3 (as submitted to Congress by the President) says that the USTR 'shall have primary responsibility' for 'developing and for coordinating the implementation of U.S. international trade policy.'" Ibid, p. 67.

tions to the political level, enabling/forcing policy decisions to be made about goals, priorities, and strategies. The status of such an agency would offer high prestige and political leverage to formulate policy, and could offer a place for policymakers to coherently think about international telecommunications policy, rather than responding to the wishes and whims of private sector and Federal agency interests.

The main disadvantage to such an agency is the very real threat that the office could become too political-a charge often leveled at the USTR. Rather than aggressively formulating policy and pursuing long-term negotiation strategies, this new agency could be "captured' by U.S. industry or the administration in power. It would be extremely important to build in openness and public accountability into the procedures of such an agency.

## Approach 3

In the long term, the changes needed in the U.S. radiocommunication policy development process may be realized only as part of a more sweeping reordering of the Nation's entire telecommunication policymaking structure, Sustained congressional efforts would be required to make these changes. As noted in chapter 3, each of the agencies involved in the management (and/or regulation) of spectrum resources has its own problems and limitations that constrain its effective participation in the policymaking process. The FCC is critically short of funds to do its job, and this has caused it to take a primarily reactive approach to policymaking. NTIA is hampered by its sometimes conflicting roles as presidential telecommunications advisor and Federal Government spectrum manager. And the role of the State Department needs clarification and perhaps redefinition. See chapter 3 for further elaboration of these issues and options.

The third and most radical approach to improving U.S. radiocommunication policymaking involves restructuring or reorganizing all or part of the existing domestic policy structure. This approach would take many years to debate, build support for, and enact.

Some analysts believe that as long as the current structures (FCC, NTIA, and State Department) and divisions in authority (Federal Government vs. private sector and State/local government) continue to exist, there is little chance that a coherent international radiocommunication policy can be articulated and maintained in the long term. These analysts believe that policy development for both government and nongovernment spectrum use must be combined in order to achieve a focused approach to both policy and international negotiation.

From this perspective, many observers view the disbanding of the Office of Telecommunications Policy (OTP) in 1978 as a mistake.[66] They believe that a high-level (White House) focus is needed once again for U.S. telecommunications policy. Still others believe that a cabinet-level position is needed—a Department of Communications. Disagreements over the form of this restructuring reflect the lack of consensus over the importance of telecommunications policy and what the best format for developing that policy is.

While presidential leadership, or at least support, would be necessary for any of these options to come into being, Congress has an important role to play in considering the implementation and implications of these proposals. Long-term congressional leadership in the development and articulation of U.S. radiocommunication policy could be the vehicle through which such changes are enacted, and the creation of such an agency or department may help to solidify the congressional role in the future development of U.S. radio- and telecommunications policies. Efforts to restructure the process would also demonstrate the

66 OTP functions were transferred to NTIA.

importance Congress places on the issues of telecommunication policy in this country.

OPTION 1. *Reestablish the Office of Telecommunications Policy in the White House.*

This office would be responsible for developing all domestic and international telecommunications (including radio) policy for the executive branch. Similar to the establishment of a USTR-type position noted above, such an agency would confer needed high-level attention to the problems of telecommunications and would offer a mechanism for more effectively coordinating long-term policy development and resolving policy level disputes between agencies. The creation of such an office would entail moving responsibilities for radio- and telecommunications as outlined in the options below. Changes could be accomplished through executive order.

OPTION 2. *Transfer responsibility for international telecommunications out of CIP or out of the State Department entirely.*

*If* Congress decided that CIP was no longer necessary in a restructured international telecommunication procedure, CIP's functions could be transferred to another bureau of the State Department.[67] This action would likely require Congressional action since CIP was established by Congressional mandate.[68] This could result in either effectively burying CIP, and presumably effectiveness, or conversely, if CIP's functions were taken over by a strong division of the State Department, or if CIP continued to exist within a strong division of State, the effectiveness of the office could be enhanced. Alternatively, CIP's functions, and the responsibility of the State Department for international telecommunications representation, could be transferred to NTIA, a newly created international radiocommunications agency, or a new OTP.

OPTION 3. *Decouple NTIA's dual roles as presidential advisor on telecommunications matters and manager of the Federal Government's spectrum use.*

As argued in chapter 3, the two roles can conflict and give the appearance of being incompatible in many instances-WARC preparations, for example. Two choices are possible. First, transfer IRAC duties and support out of NTIA. IRAC existed before NTIA, and could be made into a separate organization with a separate budget. This would sever the now direct policy development lines from IRAC to NTIA and give NTIA more autonomy to make policy decisions in the public interest and with less influence from IRAC. Under this option, the question of whether to leave NTIA as the manager of Federal Government spectrum is problematic. Some could argue that separating IRAC from NTIA would sufficiently protect the public's interest by decreasing the power of IRAC over NTIA policymaking. However, the ties between the two agencies could continue to be too close to permit truly independent policy development. IRAC might have to assume a broader role as the Federal Government spectrum manager, an option that would seriously reduce the role and staff of NTIA.

An alternative choice is to leave IRAC in NTIA, but separate out the role of presidential telecommunications advisor from NTIA and put it in the White House. One possible place to vest this authority is the Office of Science and Technology Policy or a new OTP. Another possibility would be to transfer it to a special telecommunications representative, like USTR, noted above. This action would leave NTIA free

67 The State Department recently restructured its operations, revoking CIP's bureau status and placing it under the Bureau of Economic and Business Affairs. This could affect both CIP's stature and its ability to carry out its statutory responsibilities.

68 In early 1990, for example, Representative Edward Markey considered proposing legislation that would have removed authority for international HDTV negotiations from the State Department and placed it in the Department of Commerce.

to concentrate on its responsibilities as Federal Government spectrum manager.

OPTION 4. *Create a separate cabinet-level agency, a Department of Communications that would include an international radiocommunications junction.*

This option would abolish the FCC, NTIA and CIP, and transfer their functions to one integrated department that would have overall responsibility for developing and implementing national telecommunications policy, and negotiating at international meetings.

The advantages and disadvantages are similar to those for Approach 2 above: international telecommunications policy would gain a more solid political base from which to settle disputes and set goals and priorities. However, the department could become another pawn in political battles, or be captured by industry. There is little discernible support for this idea among members of Congress.

The most far-reaching changes would be accomplished through the establishment of a central telecommunications agency combined with a major commitment to an industrial policy for the telecommunications industries. Such a commitment would require the most active and long-term congressional involvement. This approach could be accomplished through existing structures or through a centralized telecommunications agency. The benefits of such an approach would be to raise the level of policymaking to a higher level, and to focus greater attention, and hopefully resources, on telecommunications policy issues. The disadvantages include the effects of poor planning and decisionmaking and a danger of even greater politicalization of the issues.

# Outcomes and Implications for U.S. Radio Technology

2

WARC-92 considered a host of issues that were technically complex, interrelated, and contentious. Many of these issues were left over from previous WARCs, but the conference also considered frequency allocations for a number of new services and technologies. As a result of the month-long deliberations, conference delegates reached agreement on a broad range of allocation and regulatory issues. This chapter examines the outcomes of WARC-92, the factors that contributed to the success and/or failure of U.S. proposals, and the implications WARC-92 decisions will have for the development of radio technology in the United States and the making of future radiocommunication policy.

## FACTORS COMPLICATING ASSESSMENT OF WARC-92 OUTCOMES

Although the United States achieved many of its objectives for WARC-92, U.S. proposals were generally less successful than popularly reported, How much less is open to debate. Members of the delegation leadership point cut that the United States was very successful in ''opening the door' to several important new services, and on many issues of lesser importance, U.S. proposals were accepted by WARC-92. These officials take a long view of the process of international spectrum management, and note that additional gains will be pursued at future conferences. They do not see the fact that the United States did not get everything exactly as proposed as a failure, but rather as an expected outcome and as part of a longer-term U.S. strategy in international spectrum policymaking.



Many factors complicate an evaluation and analysis of the decisions reached at the conference. Some of these factors are technical, some procedural, and some interpretive. In addition, as

economic, technical, and political needs change, policies regarding radiocommunication services and the effects of those policies can be expected to change as well. As a result, assessing the future of specific services is difficult and somewhat speculative. The discussion below presents the most likely developments in these technologies and services based on current knowledge of technical details, negotiations, and political priorities.

## Differences in Interpretation

Evaluation of the outcomes of WARC-92, or any other international conference, is complicated by differences in perspective and interpretation. Different people, depending on their job or affiliation, have different perspectives, and as a result, interpretations and evaluations of events and decisions can vary significantly. Defense Department evaluations may differ from Federal Communication Commission (FCC) assessments, which could be wholly different from an analysis by someone in the private sector. Even among the members of the U.S. delegation—who supposedly all have U.S. interests at heart-this divergence of opinions exists.

In describing and analyzing the implications of any international conference, there is a tendency for those involved to simplify the issues and put the best possible light on the outcomes achieved. Since the close of WARC-92, government and private sector representatives have endeavored to accentuate the positive results of the conference while downplaying negative outcomes. In some cases, this ''positive spin' makes issues easier to understand. In other cases, however, ' 'spin' ' can cloud the issues, covering possible strategic or policy errors and making assessments of U.S. performance more challenging. In the case of WARC-92, the effects of ' 'spin'' have been compounded by the complexity of the decisions made and the secrecy surrounding several of the issues—it is difficult to evaluate results when they are not necessarily final or well-defined.

In addition, it is important to remember that WARCs are negotiations, and as is the case for almost any international negotiations, it is unreasonable to expect that one side will get all it desires. Such was the case for WARC-92. In order to fairly evaluate the outcomes of the conference, it is important to understand how specific goals for the negotiations were developed and what strategies were used to pursue them. In some cases, for example, negotiating positions (based on amounts of spectrum requested) were established that might have been more extreme than was actually needed. These proposals might not have been expected to succeed entirely, but were put forth as bargaining chips in order to provide negotiating room. In such cases, a narrow analysis that simply compares proposals with results may lead to an overly negative judgment about the outcomes of WARC-92 for the United States.

## Procedural Issues

The problem of assessing WARC-92 outcomes is exacerbated by the way decisions are reached at WARCs and the way the international Table of Frequency Allocations is written. In WARC negotiations, frequencies are allocated to specific radio services and become part of the international Table of Frequency Allocations (see figure 1-1). However, footnotes are often added to these allocations that further define or constrain how, when, or where individual services can be used and by which countries. [1]

[1]Footnotes to the international Table of Frequency Allocations, just like the footnotes in this report, further describe or limit the allocations listed in the table. They are designated by number and letter-731X (see figure 1-1 in chapter 1, which shows a sample page from the international Table of Frequency Allocations, including how footnotes are presented). Footnotes are used for a variety of purposes, including to specify power levels, reference relevant resolutions, and allocate additional services. Footnotes are also used by a country (or countries) to preserve some measure of national sovereignty when they disagree with the allocations that were made internationally. These country footnotes can make alternative or additional allocations or can limit operations within those countries.

Often, adding footnotes to the allocations table is the only way to reach agreement. A country (or countries), for example, may decide that it cannot agree with an allocation that has been agreed to internationally because of its existing uses. The dissenting country will attempt to have a footnote placed in the allocation table noting its use of the frequencies or making an alternative allocation that applies only to it. At WARC-92, for example, the members of the International Telecommunication Union (ITU) decided to allocate the 1452-1492 MHz band to the Broadcasting-Satellite Service-Sound (BSS-Sound) on a coprimary basis. The United States, however, in order to protect domestic aeronautical telemetry uses—aircraft testing and weapons development—placed a footnote (in the form of an alternative allocation) that prohibits those frequencies from being used in the United States for BSS-Sound. In addition to footnotes, WARCs also adopt resolutions and recommendations that set conditions on the use of some frequencies that will affect how allocations can be implemented. Resolutions and recommendations also identify areas requiring further technical study by the International Radio Consultative Committee (CCIR) (see appendix C for a select list of WARC-92 resolutions and recommendations).

WARC-92 made many important changes to the international Table of Frequency Allocations, but also inserted many footnotes that will constrain the use of those new allocations.[2] In fact, delegates at the conference had a joke about the number and complexity of the footnotes they had agreed to: ''what the allocations giveth, the footnotes taketh away. " At the close of the conference, a representative of Canada remarked that he was glad the conference was over so he could go home and determine just what he had agreed to. Olof Lundberg, Director-General of Inmarsat, echoed this sentiment after the conference ended: "I think all of us who want to be players in new areas have a challenging time ahead to find out to what degree this spectrum is usable. Thus, concentrating only on the allocations that were adopted could lead one to conclude that the results of WARC-92 were more favorable for the United States than they actually are. A thorough analysis of the decisions of the conference requires careful consideration not only of the allocations, but also of the sometimes technically complex, sometimes deliberately vague footnotes that accompany the allocations.

## Technical Issues

Finally, in analyzing the outcomes and implications of WARC-92, several important technical caveats must be noted that will affect how and when WARC-92 decisions will be implemented, First, many of the technical details that will affect the future of these services and technologies are still undecided, and will be negotiated amongst the stakeholders over the next several years. In addition, WARC-92 called for the CCIR, which studies technical matters relating to radio technology, to conduct studies on many of the systems and services addressed at the conference. These studies will guide future revisions of the decisions made at WARC-92.

Second, the decisions and allocations made at WARC-92 are not cast in stone. Although WARC-92 has been described as the last of its kind, it will not be the last world radiocommunication conference, and future conferences will very likely change, reverse, or otherwise modify the decisions and allocations made at WARC-92. According to the recent restructuring of the ITU (see chapter 3), future world radio conferences will take place every 2 years-each dealing with a single topic or very limited range of topics. It is likely (and required in some cases) that these conferences will modify the allocations and foot-

[2]For mobile services, e.g., more than 30 new footnotes were added that define power levels and sharing criteria, limit usc to certain countries, and specify dates for implementation.

[3]**Quoted in** Bob Chapin, ''Inmarsat: MSS Evolution or Revolution?" *Satellite Communications,* August 1992, p. 36.

notes made at WARC-92 based on CCIR studies and as a result of new technological developments.

In addition, the decisions made at WARC-92 will be subject to continuing interpretation (and reinterpretation to fit changing national priorities) over the next two decades. Since many of the services (and systems) discussed at WARC-92 are still being developed, their operational characteristics are still unknown, Consequently, the procedures and regulations that govern their use will likely change over time as experience sharpens understanding.

The implications of WARC-92 are also difficult in some cases to foresee because of the long transition times involved. The ITU often makes allocations effective 10 or 15 years in the future in order to give existing users of the bands adequate time to move to other frequencies. So, for example, the full force of some of the decisions of WARC-79 are just now beginning to be felt. Likewise, some WARC-92 allocations are not scheduled to come into effect until 2007—15 years from now. It may take almost that long to work through the nuances of the WARC-92 footnotes, and in that time, technology will have continued to advance rapidly. Radio services will have gone through several generations of improvements, and new applications will have been developed. Policies, rules and regulations will continue to evolve in response to technology developments. For these reasons, evaluating the outcomes of WARC-92 is, in one sense, premature. Rather, the outcomes of WARC-92 must be examined as one piece in a longer process that stretches out for many years before and after.

## U.S. OBJECTIVES FOR WARC-92

The general goals for the United States at WARC-92 were to enhance the competitive position of the United States in radiocommunication technologies and services, and allow new radio services and technology systems to be developed as quickly and flexibly as possible. In pursuit of these goals, the U.S. delegation had several objectives for WARC-92:

- Support allocations for new services, such as low-Earth orbiting satellites (LEOS), BSS-Sound, and general satellite service (GSS), as well as the expansion of allocations for existing services, such as the Mobile-Satellite Service (MSS) and high-frequency broadcasting (HF).
- Protect important domestic radio operations by preventing new services from operating in the same bands and interfering with the incumbent services. This was an important concern for allocations in the L-band (approximately 1.4-1.6 GHz), the 14.5 -14.8 GHz band, and the frequencies just above 21.4 GHz, among others.
- Assure that new and existing allocations are more flexible and less constrained by regulation-allowing U.S. companies to exploit their technical strengths in international markets.
- Promote development of new radiocommunication technologies, an area in which the United States is a world leader.

In some cases these objectives conflicted with each other. During the domestic preparations for WARC-92, for example, U.S. policymakers were forced to choose between protecting the important civilian and military uses of the L-band for aircraft and weapons testing and promoting new digital broadcasting technologies that had been proposed by the private sector. In such cases, intense policy disputes erupted, the undercurrents of which carried over into the conference.

The sections below discuss the most important allocation issues debated at WARC-92.[4] Each

[4] Other matters besides new allocations for radio services were discussed at WARC-92. However, the main focus of the conference was on allocations, and allocation issues consequently are the focus of this report. For a full discussion of the U.S. positions for WARC-92, negotiating issues, and final results, see U.S. Department of State, *United States Delegation Report: World Administrative Radio Conference,* International Telecommunication *Union, Malaga-Torremolinos, Spain, 1992,* publication 9988, released July 1992.

### Box 2-A—Primary and Secondary Radio Services

When radio frequencies are allocated to a specific radio service by the countries of the International Telecommunication Union at a WARC, the service is also given a class of service, usually either primary or secondary. These designations define the rights and responsibilities each service has in its allocated frequencies. When two or more services share the same band of frequencies, as is often the case, these class designations also describe how the services should relate to each other in terms of sharing and coordination.

**Primary** radio services have full rights to use any or all of the radio frequencies that have been allocated to it, unless modified by a footnote to the international Table of Frequency Allocations. Such a footnote could specify certain countries in which the service may not operate or could specify certain technical constraints such as maximum levels of power allowed. When two primary services share the same frequencies, they must coordinate their use, if necessary, to ensure that interference is minimized.

**Secondary** radio services are not allowed to cause interference to primary services and cannot claim any protection from interference from primary services. They must accept interference from a primary service if it occurs.

When developing and implementing a new service, a primary allocation is preferable since it confers certain rights and protections. Secondary allocations, on the other hand, can constrain development of a new service. In simple cases, secondary services must conform to the requirements of the primary services using the band. This may require systems planning to offer a new service to be redesigned or substantially modified, which can be costly in terms of time and money. System modifications can often reduce system capacity, coverage, or quality. If a new secondary service is not able to share with the existing primary services, it is not permitted to operate.

SOURCE: Office of Technology Assessment, 1993. Complete definitions and further information on radio services can be found in 47 CFR 2.104.

section provides a brief background on the service and technology, discusses the U.S. proposals and how well they fared at WARC-92, and examines the implications for the service now that agreements have been reached.[5]

## HIGH-FREQUENCY BROADCASTING

### Background

The frequencies from 3 to 30 MHz are referred to as the high-frequency band or, more commonly, the shortwave band. Because radio waves in these frequencies can travel long distances (beyond the horizon), they are extensively used by amateur radio operators, international government (Voice of America, British Broadcasting Corporation, and Radio Moscow) and private (religious) broadcasters, and for national and international aviation, maritime, and emergency communications.[6] Many developing countries use these bands primarily to provide domestic point-to-point communications.

International broadcasters typically transmit news and information services and religious programming as well as music. Many countries, including the United States, use shortwave broadcasting to champion their political, cultural, and economic beliefs around the world. In this role, HF broadcasting is viewed by many nations as an

[5] All information on U.S. proposals comes from U.S. Department of State, *United States Proposals for the 1992 World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum*, Department of State publication 9903, July 1991.

[6] Although more than 100 countries currently use HF frequencies to broadcast information programming internationally, large-scale international broadcasting is limited to perhaps a dozen (mostly industrial) countries, including Australia, Canada, China, Cuba, France, Germany, Japan, the Netherlands, Russia, the United Kingdom, and the United States. For a brief discussion of the history of international HF broadcasting, see James Wood, "Growth Explosion in International I-IF Information Broadcasting," *Telecommunications Policy, vol.* 15, February 1991, pp. 22-28.

U.S. Information Agency



*The United States uses high-frequency broadcasting towers like these in the Phillipines to transmit radio programs around the world.*

important tool of foreign policy. In the past, for example, HF broadcasting was instrumental in delivering propaganda programming during times of war. This function was important during the Cold War, but today, the overt propaganda content of the broadcasts has been toned down and more emphasis is put on communicating American values and viewpoints. The United States currently broadcasts more hours of international programming than any other country.

For many years, the amount of spectrum allocated to HF broadcasting has been recognized by most countries as critically inadequate, especially in the most valuable (and congested) bands below approximately 10 MHz.[7] Part of the reason for this congestion is simple numbers-there are more broadcasters than available frequencies. Planning exercises conducted for the 1987 High Frequency Broadcasting WARC (HFBC-87), for example, indicated that more than 50 percent of all HF broadcasting needs submitted by member countries could not be adequately met, and between 25 and 35 percent of these needs could not be met at all.[8] In 1990 the National Telecommunications and Information Administration (NTIA), concluded that 2 to 4 times more spectrum (depending on specific frequency bands and modulation techniques) was needed to meet

[7] The bands below 10 MHz are especially coveted by broadcasters and other HF users because they are much more reliable than the frequencies above 10 MHz. Frequencies above 10 MHz that are used for long distance communication are often affected by sunspot activity, which varies by the time of day and by season. When this happens, the broadcasters in the upper bands reset their transmitters to the lower frequencies, causing even more interference and congestion.

[8] WARC-92 Industry Advisory Committee, "Final Report of Informal Working Group Number l," report submitted to the Federal Communications Commission Apr. 24, 1991.

current HF broadcasting requirements. The International Frequency Registration Board (IFRB) reached similar conclusions in its report to WARC-92.[9]

One reason behind the great demand for HF frequencies is that multiple frequencies are often needed to deliver programming to a given geographic area over the course of a day. Different frequencies have distinct transmission characteristics that make them suitable for long-range transmission during specific hours-different frequencies, for example, are used at night and during the day. Thus, in order to provide continuous coverage to a specific region or city, frequencies must be changed as the day progresses. For example, Voice of America (VOA) uses seven frequencies to deliver programming g to Beijing, China. The problems in providing adequate coverage to an area as large as China or Africa are enormous and achieving adequate quality and coverage may require many different frequencies.

The international regulatory system also contributes to the congestion of the HF broadcasting channels. HF broadcasting is not regulated, for example, as AM/FM radio is in the United States—where one station is assigned to one channel in a specified geographic area. This assignment process substantially reduces interference between stations. International HF broadcasting, on the other hand, has much less stringent limits. Although the use of specific frequencies is supposed to be coordinated internationally, and the FCC regulates U.S. broadcasters, in other countries broadcasters often transmit anytime, anywhere they want-as long as the band is allocated to HF and they follow the international Radio Regulations (and sometimes even this is not adhered to).[10] Some of the most sought-after frequencies can have as many as 10 stations operating on them.

## U.S. Proposals

The United States made several proposals relating to HF allocations and regulations. First, based on the need for additional frequencies for HF broadcasting, and in order to balance the amount of spectrum available in the ITU's 3 regions (see figure 1-2), the United States proposed to allocate an additional 1325 kHz in ITU Region 2, and an additional 1125 kHz in Regions 1 and 3. The following additional HF broadcasting allocations were proposed for Region 2:

| | |
|---|---|
| 5900-5950 kHz | 13800-13900 kHZ |
| 7200-7525 kHZ* | 15600-15700 kHZ |
| 9350-9500 kHz | 17450-17550 kHz |
| 11550-11650 kHz | 18900-19300 kHZ |

*The United States proposed to add only 125 kHz in this band for ITU Regions 1 and 3 in order to align the HF broadcasting bands worldwide (existing HF broadcasting allocations in these regions exceeded those in Region 2). This accounts for the difference in total proposed allocations.

All these allocations except the 18900-19300 kHz would be contiguous with existing HF broadcasting bands.

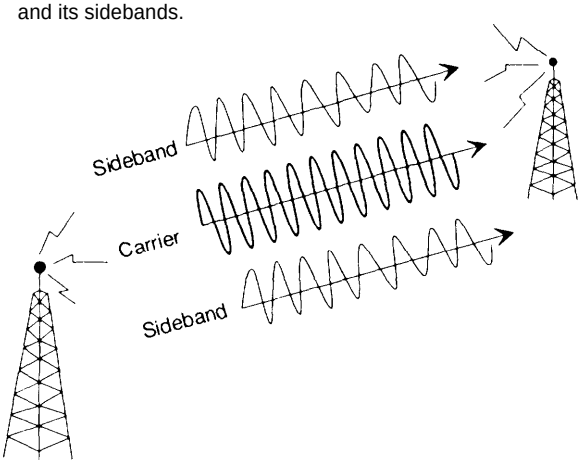
In addition, the United States proposed that all new allocations be required to use a transmission

[9] U.S. Department of Commerce, National Telecommunications and Information Administration, *Spectrum Required for HF Broadcasting,* NTIA Report 90-268, October 1990. Internation.al Telecommunication Union, Document 4 of WARC-92, Malaga-Torremolinos, Spain, February 1992.

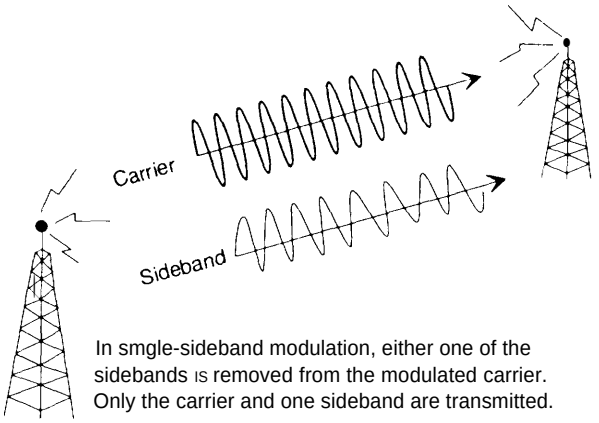
[10] The International Frequency Registration Board does have to be notified that such operations are beginning, but the IFRB has no real power to prevent stations from operating on any frequencies they want.

**Figure 2-l—Single Sideband Modulation**

In order to transmit information using radio waves, the reformation to be sent (music or voice) IS impressed onto a carrier wave. As a result of this process, sidebands are created that actually contain the music or voice Information of the signal. Radio receivers extract the music or voice reformation from the carrier and its sidebands.




When both upper and lower sidebands are transmitted, the method IS called double sideband modulation.




In smgle-sideband modulation, either one of the sidebands IS removed from the modulated carrier. Only the carrier and one sideband are transmitted.

**SOURCE: Office of Technology Assessment, 1993, adapted from Harry Mileaf, cd.,** *Electronics One* **(Rochelle Park, NJ: Hayden Book Company, Inc., 1976),**

technique called reduced carrier single-sideband (SSB) modulation (see figure 2-1).[11] SSB reduces the amount of spectrum each radio signal/station needs, thereby allowing more users to share the band.[12] In order to encourage the early use of SSB, the United States also proposed advancing the date (agreed to at HFBC-87) when all broadcasting must be converted to SSB from the year 2015 to 2007.

Finally, the United States proposed to align the differing regional HF broadcasting and amateur radio service allocations around 7 MHz—creating a worldwide allocation for HF broadcasting at 7200-7525 kHz. A procedure for reaccommodating existing services displaced by these changes was also proposed.

## Results

United States HF proposals achieved mixed results at WARC-92. The conference allocated only 790 kHz of additional spectrum to HF broadcasting, of which 200 kHz is located in frequencies below 10 MHz (the most congested portion of the HF bands). The remaining 590 kHz was allocated between 11 and 19 MHz. All the newly allocated bands are allocated on a worldwide basis (see table 2-l).

Two significant limitations were put on the use of these new frequencies. First, they cannot come into operation until April 1, 2007. At that time, broadcasting will become the exclusive primary service operating in the bands. Point-to-point and mobile services, however, will be able to use the bands after this date, but only within the boundaries of a country and only on a low-power, noninterference basis. WARC-92 Resolution 21 defines the conditions for the phase-in of the broadcasting service in these newly allocated bands.

---

11 Currently, most international shortwave broadcasting uses a transmission technique called double sideband.

12 Contrary t. intuition, the increase in spectrum availability would not be 2:1. NTIA estimates gains of about 1.8:1, while the ITU/IFRB estimates that the efficiency gain would be approximately 1.5:1, meaning that 2 existing double-sideband channels could be converted into 3 new SSB channels.

Table 2-1—WARC-92 High-Frequency Broadcasting Allocations

| Frequency | Amount | Frequency | Amount |
|---|---|---|---|
| 5900-5950 KHz | 50 KHz | 11600-11650 KHz | 50 KHz |
| 7300-7350 KHz | 50 kHz | 12050-12100 KHz | 50 KHz |
| 9400-9500 KHz | 100 KHz | 13570-13600 KHz | 30 KHz |
| | | 13800-13870 KHz | 70 Khz |
| | | 15600-15800 kHz | 200 KHz |
| | | 17480-17550 KHz | 70 KHz |
| | | 18900-19020 KHz | 120 KHz |
| | 200 KHz | | 590 KHz |

SOURCE: Office of Technology Assessment, 1993.

Second, WARC-92 prohibited use of these additional bands until a process for planning the HF broadcasting spectrum has been completed. This restriction is defined in Resolution 523, which also calls for a WARC to establish planning procedures. However, United States HF broadcasters believe that planning will be meaningless until more spectrum is allocated, The United States entered a formal reservation in the Final Acts of WARC-92 to protest the small amount of spectrum allocated to HF broadcasting and other limitations put on use of the bands.[13]

On its other HF proposals, the United States was more successful. WARC-92 did agree that all new bands should be required to use SSB transmission, but did not accept the U.S. proposal to advance the date for conversion of all HF broadcasting to SSB from 2015 to 2007. The conference did, however, adopt Recommendation 519, which recommends that the next WARC again consider advancing the date for replacing current double-sideband transmissions with more spectrum-efficient SSB techniques. WARC-92 did not accept the U.S. proposal for aligning the world's HF broadcasting bands around 7 MHz, but Recommendation 718, proposed by Mexico and supported by the United States, was adopted that calls for a future conference to address the issue. Finally, WARC-92 accepted U.S. proposals for reaccommodation procedures and secondary status for freed and mobile users in the HF bands. WARC-92 also adopted Recommendation 520 that member governments take steps to shut down HF broadcasters who are using frequencies outside the designated HF broadcasting bands.

## Discussion

### DOMESTIC ISSUES

**In the** domestic preparation process for HF broadcasting, the primary issue was how much additional spectrum the United States should propose to be reallocated for HF broadcasting uses. This debate pitted private broadcasters and several agencies of the Federal Government (U.S. Information Agency (USIA)/VOA and Radio Free Europe/Radio Liberty) against other U.S. Government users, including the Departments of Treasury (Coast Guard) and Justice (Federal Bureau of Investigation).

During the preparations process, the FCC's Industry Advisory Committee (IAC) recommended that 2455 kHz of additional spectrum be allocated for HF broadcasting. Defense and other government HF users proposed far smaller amounts, and a compromise of 1325 kHz was tentatively

13 "In the view of the United States of America, this Conference failed to make adequate provision for the HF needs of the broadcasting service, particularly below 10 MHz, despite an earnest effort to do so. The IFRB's Report to the Conference shows that broadcasters' requirements far outnumber the channels available in the bands between 6 and 11 MHz (where spectrum is urgently needed) and that planning will not work effectively without additional and adequate HF spectrum. Therefore, the United States of America reserves the right to take the necessary steps to meet the HF needs of its broadcasting service. " International Telecommunication Union, *"Declarations," WARC-92 Document 389-E, Malaga-Torremolinos, Spain, Mar. 3, 1992, p. 29.

reached. What happened next is disputed, but final proposals included only 1325 kHz. USIA and VOA, joined by private broadcasting interests, complained to NTIA that this amount was inadequate, and proposed an additional 60 kHz. Other government agencies, including the Coast Guard and Federal Bureau of Investigation, opposed this addition, citing the use of the specified band for drug interdiction activities. NTIA agreed with these agencies, and rejected VOA appeal—the final proposal to WARC-92 was for 1325 kHz. In an attempt to force official U.S. proposals to include more spectrum for HF broadcasting, VOA, representing government and industry broadcasters, took its case to the National Security Council (NSC) in early January 1992.[14] NSC did not act on VOA's request until after WARC-92 had ended, effectively nullifying VOA's appeal.

The clash over allocations for HF broadcasting has become controversial. Different players in the debate hold conflicting views of what happened and when: What information was shared? When were decisions made and who made them? How carefully were the factors surrounding the issue considered? Because the debate involved existing government use of the HF bands, much of the preparations and debate regarding HF broadcasting allocations were conducted in the Interdepartment Radio Advisory Committee (IRAC), the deliberations of which are largely restricted from public view.[15] The issues surrounding the battle over additional HF spectrum and its implications for long-term U.S. radiocommunication policy development are discussed in chapter 1.

Ultimately, the domestic battles over HF broadcasting proposals most likely had no effect on the WARC-92 outcome. Even if the United States had proposed more spectrum, as did the Europeans, it is unlikely that the developing countries would have agreed to any further allocations. A few analysts disagree. They believe that if the United States had been able to develop a proposal with even more additional spectrum for HF broadcasting in a timely manner, and had joined others (the Europeans) in promoting such new allocations prior to WARC-92, that additional spectrum could have been obtained. Whether it was the result of conscious strategy or not, going into the conference with more modest proposals now makes the outcome look better than it would have if the United States had proposed the larger amount of spectrum VOA and the private broadcasters wanted.

An additional area of domestic disagreement involves the implementation of SSB technology. This conflict again involves VOA and private broadcasters, on the one hand, and other government agencies on the other. Although VOA supports the conversion to SSB in principal, and is, in fact, installing SSB-compatible transmitters, it is concerned about how and when the transition to SSB can be accomplished. VOA's position is that the cost of SSB radio receivers currently prevents their rapid adoption by VOA's listeners, and until adequate numbers of SSB radios are in use, they will resist ceasing their double-sideband

---

[14] NSC is a last resort for resolving issues that could not be resolved in the regular WARC preparation processes. It has no specific expertise in radiocommunication matters and no individual who specializes in telecommunication issues.

[15] The Interdeparment Radio Advisory Committee (IRAC) was formed in 1922 to coordinate the Federal Government's use of the spectrum. It is now located in the Commerce Department and consists of approximately 20 to 25 representatives from those Federal agencies who are the most active users of radio technologies. IRAC serves in an advisory capacity to NTIA in matters of radiocommunication policy and spectrum management. For more information on IRAC and its role in the WARC-92 preparation process, see U.S. Congress, Office of Technology Assessment, *The 1992 WorldAdministrative Radio Conference: Issues for U.S. International Spectrum Policy*, OTA-TCT-BP-76 (Washington DC: U.S. Government Printing Office, November 1991).

(DSB) transmissions.[16] Typical shortwave (HF) radio receivers are relatively inexpensive, but SSB receivers, which are being manufactured today (although not in mass market quantities), cost $175 and up, far beyond the means of most VOA listeners around the world.[17] VOA's position also may be related to a desire to move eventually into satellite (BSS-Sound) delivery of its programming. Rather than forcing its listeners to endure two format changes in the coming years, VOA may prefer to move directly into BSS-Sound delivery of its services, leapfrogging a technology (SSB) they see as only an interim (and very expensive) step.[18]

These disagreements indicate a larger policy and institutional battle that is being fought between private/government broadcasters and other Federal Government spectrum users in the arena of international frequency allocation. Defense interests are especially reluctant to reallocate spectrum for HF broadcasting (public and private) because they control much of the HF spectrum allocated for government use, and they do not want to give up any more frequencies than necessary. As a result, the HF broadcasting community reports being consistently overwhelmed in government decisionmaking processes such as the IRAC preparations for WARC-92. The issue appears to be one of agency mission. Defense-and security-related communications appear to have assumed a higher priority than international broadcasting, despite a National Security Directive (NSD-51) that affirms the important role of international broadcasting in foreign policy and supports its continued mission. Battles of this type can be expected to continue until guidelines are developed that allow government policymakers to weigh competing spectrum claims based on clearly-defined policy goals.

## INTERNATIONAL ISSUES

Unlike many other allocation issues, the debate at WARC-92 over new HF broadcasting allocations echoed past ITU differences between the developed and developing countries. For more than a decade, the United States and many other industrialized countries have been advocating increasing HF broadcasting allocations in order to meet the growing needs of international HF broadcasters. These past efforts achieved only limited success.

Historically, developing countries, who use the HF bands for fixed (point-to-point) domestic telecommunication services, have opposed expanding the allocations for HF broadcasting. They fear that such uses would interfere with or limit their point-to-point HF systems, and that increased use of these frequencies for broadcasting could make their existing equipment unusable-jeopardizing their investments in that equipment. They want to continue to use HF for domestic communications and they want to protect their investments. Many countries are also concerned about increased foreign broadcasting into their territories.

At WARC-92, these historic divisions persisted as a large and determined block of develop-

16 "USIA does not oppose conversion to SSB, which it sees as offering spectrum efficiency and possibly generator-fuel savings, provided its listeners have SSB-compatible receivers. . . USIA has consistently insisted that two related problems, the introduction of SSB-compatible transmitters and the introduction of SSB-compatible receivers, must be resolved prior to the final abandonment of DSB in favor of SSB. . .The high cost of SSB-compatible receivers, especially in the Third World, maybe a significant factor in delaying the conversion from DSB. Until and unless adequate numbers of SSB-compatible receivers are in the hands of audiences, broadcasters, and more importantly the governments that in most cases pay their bills, will be unwilling to cease DBS operations. " Review comments of Walter La Fleur, Director, Office of Engineering and Technical Operations, Voice of America, letter to David P. Wyc, OTA, Nov. 18, 1992, p. A-2.

17 Some analysts maintain that the Price of SSB receivers would come down substantially when they were manufactured in true mass market quantities. Others believe that the price of the receivers would still be prohibitively high.

18 It should be noted that ncw BSS-Sound receivers will also be very expensive when they are first introduced.

ing countries staunchly opposed allocating any more frequencies to the HF broadcasting service. The industrialized countries, including the United States and Europe as well as the Russian Federation and Japan, supported increasing the allocations. The Europeans, in fact, submitted a common proposal for new HF spectrum that exceeded even the amount proposed by the United States. Discussions over the allocation proposals at the conference were intense, and negotiations quickly became focused on the most valuable and congested frequencies below 10 MHz. After a number of formal and informal meetings and much discussion "of f-line," a compromise package was worked out that included the allocations noted above.

Although the allocations by WARC-92 fell short of U.S. objectives, the United States supported the compromise package. U.S. delegates participating in the HF negotiations felt that further discussion would be useless, citing extensive opposition to any further allocations. Developing country opposition also blocked other U.S. proposals. The U.S. proposal for advancing the conversion date for SSB, for example, met stiff resistance from the developing countries, and some developed countries, who were concerned that they could not afford to refit or replace their equipment any faster than the original date of 2015.

This case points out the difficulty of balancing domestic and international factors in developing proposals. Domestic users need more spectrum, which led the United States to propose large additional allocations. Many (primarily developing) countries, however, oppose expansion, meaning that a smaller proposal might have had better chances for success internationally. U.S. proposals represented an attempt to strike a balance between these two conflicting forces.

## Issues and Implications

### FREQUENCY ALLOCATIONS ARE STILL INADEQUATE

From the U.S. perspective, despite the allocations made at WARC-92, the amount of spectrum allocated for HF broadcasting is still inadequate. This means that the HF broadcasting bands will continue to be congested and subject to high levels of interference among stations around the world. Furthermore, the limitations placed on the implementation of the new HF broadcasting frequencies mean that these bands will not be available for HF broadcasting for at least 15 years. Given the shortage of spectrum that currently exists, the decisions made at WARC-92 will not solve broadcasters' immediate needs.

Several long-term questions regarding HF broadcasting remain. How can the United States best meet its HF broadcasting requirements given the limitations and restrictions of the WARC-92 allocations? What constraints, if any, will the inadequacy of allocations put on future U.S. HF broadcasting activities? Will future international broadcasting services require more high frequency spectrum or can other technologies be used to alleviate the shortage?

The options available to the United States are limited. According to the U.S. reservation in the Final Acts of WARC-92, the United States will take all steps to meet the needs of its broadcasters. In practice, this may mean that U.S. broadcasters will use the frequencies allocated at WARC;-92 immediately, in spite of the implementation date of 2007. Despite ITU agreements and resolutions that prohibit broadcasting in frequencies out of the specified bands, many countries, including the United States, have been forced to use bands other than those allocated to HF broadcasting to meet their domestic HF broadcasting needs.[19] In the future the United States may be forced to expand

[19] Number 342 of the Radio Regulations permits such operations provided they do not cause interference to the allocated services. International Telecommunication Union, *Radio Regulations* (Geneva, 1982).

its use of prohibited frequency bands in order to meet its broadcasting requirements.

### PLANNING

Planning the HF broadcasting spectrum is closely linked to the amount of spectrum that has been allocated for HF broadcasting. From the U.S. perspective, any attempt at planning before adequate spectrum is allocated would be difficult and most likely unsuccessful. The United States will fight attempts to plan the spectrum until it believes that allocations are adequate and/or until an adequate planning system is developed.[20]

Aside from arguments that insufficient spectrum exists for planning, the United States has historically opposed *a priori* planning of the spectrum. Government officials believe that such planning reduces the flexibility to meet as yet undefined future needs and leads to inefficient utilization of spectrum resources, U.S. spectrum policymakers may also fear that because spectrum is in such limited supply, and because the United States is the world's largest user of the HF spectrum, that ITU planning could force U.S. HF broadcasters to give up frequencies in order to make room for other countries. Thus, it is unclear in any case if the United States would ever support the formal planning of the HF broadcasting bands. From the perspective of developing countries, like the past battle over geosynchronous orbital slots for satellites, this is a question of equity and fairness they have been pursuing for some time, and which continues to be important to them. The issue of HF planning will continue to be contentious for many years.

### SINGLE-SIDEBAND TRANSMISSION

Single-sideband transmission is not a new technology. Amateur radio operators, the military, and some marine and aeronautical users have been using it for many years. Converting these types of (point-to-point) radiocommunication systems to SSB is easier than for mass market broadcasting operations because commercial services and the military have greater financial resources and the ability to more completely control the transition process—allowing them to implement transmitters and receivers simultaneously. Broadcasters, on the other hand, directly control only the transmission of the signal; they cannot force listeners to buy new radios.[21]

Although SSB radios are available, they are not a truly ''mass market" product. Currently, SSB receivers are available commercially for $175 and up in the United States. These prices will slow the widespread introduction of these radios in the developing nations of the world. If and when mass market economies are realized, the price of SSB radios will fall, Whether such radios will be produced cheaply enough to sell worldwide, and when, however, are open questions. Developing a market for such products will be difficult until more broadcasters (are forced to) start using SSB transmissions for their programming. The conversion to SSB in the United States will continue to be a difficult issue. Because of this, broadcasters will probably continue to insist that sufficient numbers of SSB-compatible receivers be in the hands of their listeners before abandoning DSB in favor of SSB systems.

### BSS-SOUND

**The** congestion in HF broadcasting bands and the relatively low reliability and quality of some of the frequencies is pushing international broadcasters to look for alternative means to deliver programming. An important future possibility in international broadcasting is the deployment of

20 Despite efforts to date, the development of a computerized planning model has not been successful. Systems that have been developed so far have suffered from various technical flaws that made them unacceptable to ITU members. It is unclear how vigorously further development efforts are being pursued.

21 Broadcasters are faced with a chicken-egg scenario. Consumers do not have SSB radios and do not want to buy them until there 1S Sufficient programming to listen to. Broadcasters will resist broadcasting to listeners who cannot hear them-unless they are forced to. One possible solution is to develop inexpensive dual-mode radios capable of receiving both SSB and DSB transmissions.

broadcasting systems that use satellite technology. Such systems would cover larger areas than terrestrial transmitters, and if such systems are licensed and operated regionally and/or globally, they could replace traditional HF broadcasting as the medium of choice for international broadcasters.[22] The deployment of only a small number of satellites could beam hundreds of channels of programming around the world, thereby relieving some, if not all, of the current congestion of the HF broadcasting bands. Many HF broadcasters, including VOA, see the future of international broadcasting in satellites. Direct broadcasting from satellites could provide worldwide coverage for U.S. broadcasters that is more complete, reliable, and of higher quality than that available with HF technology.

One important issue that will have to be addressed at future ITU meetings before BSS-Sound international broadcasting can go forward is the legitimacy of cross-border satellite transmissions. Currently, HF broadcasting across national boundaries is internationally recognized as a legitimate activity, although some countries do attempt to jam foreign transmissions entering their territories. There is currently no similar broad acceptance of international satellite broadcasting activities, and the impossibility of conforming satellite coverage areas strictly to national boundaries could cause serious difficulty in implementing such systems on a regional or worldwide basis.[23] Some countries, who want to exercise tight control on the flow of information into their countries, will seek to impose restrictions. U.S. broadcasters would prefer that future satellite-based international broadcasting be considered in the same way that HF broadcasting is today. This would allow them maximum flexibility in reaching listeners around the world.

## BROADCASTING SATELLITE SERVICE-SOUND

### Background

BSS-Sound refers to the delivery of audio programming (music, news, sports) from satellites directly to consumer radios. While no BSS-Sound services are operating yet, the systems now being developed would use digital technology to broadcast CD--or near CD-quality programming to listeners using radio receivers that would be portable/mobile and low-cost.[24] A key feature of satellite broadcasting is that it allows programmers to broadcast their signal over a wide area-the entire United States, for example-as opposed to the limited range of today's conventional terrestrial transmitters. Some developers of BSS-Sound systems plan to augment the satellites with terrestrial transmitters that would improve reception in urban areas (between buildings, in tunnels, etc.). Because these systems will send their signals in a digital format, the term digital audio broadcasting (DAB) has come into widespread use (especially in the United States) to describe this next generation of radio broadcasting, and, in fact, DAB is now commonly used to describe both satellite and terrestrial digital broadcasting systems.

Proponents of BSS-Sound see many markets for the new digital services. They are planning a variety of programming targeted to groups of users with different musical tastes, ethnic and cultural backgrounds, and special interests—groups that may not be able to support a local

[22] NTIA made this argument in opposing further allocations for HF broadcasting.

[23] In fact, No. 2674 of the Radio Regulations stipulates that "all technical means available shall be used to reduce, to the maximum extent practicable, the radiation over the territory of other countries unless an agreement has been previously reached with such countries." ITU, *Radio Regulations*, op. cit., footnote 19, p. RR30-2. Whether or not this regulation requires prior consent of countries before satellite broadcasting can be beamed into them is a topic of debate in U.S. radiocommunication policy circles.

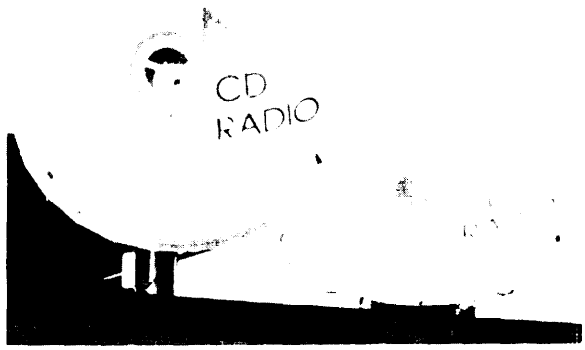
[24] Because existing AM/FM radios use analog technology, they will not be able to receive the new digital BSS-Sound signals. Consumers will have to buy new (digital) radios in order to listen to the new services.

radio station, but when aggregated across the country, make a national service possible. This concept is analogous to the programming philosophy of cable television.

In addition to audio programming g, the transmission of data services directly to users is also being explored. Proponents envision broadcasting data services to support educational needs, paging operations, and navigation and traffic management systems for the Nation's cars and highways. In addition to purely domestic services, international broadcasters see BSS-Sound technology as an important new way to transmit radio programming around the world—a service that would allow them to reach listeners with higher quality than the HF broadcasting they use today.

BSS-Sound applications have been studied internationally for at least 25 years. The members of the ITU first considered allocating frequencies for BSS-Sound services at the 1979 WARC. That conference and subsequent WARCs, however, were not able to agree on specific allocations, and as a result, the matter was deferred for consideration by WARC-92.

Satellite CD Radio




*Satellite dishes such as these will beam digital quality radio programming up to satellites that will then retransmit it across the country.*

## U.S. Proposal

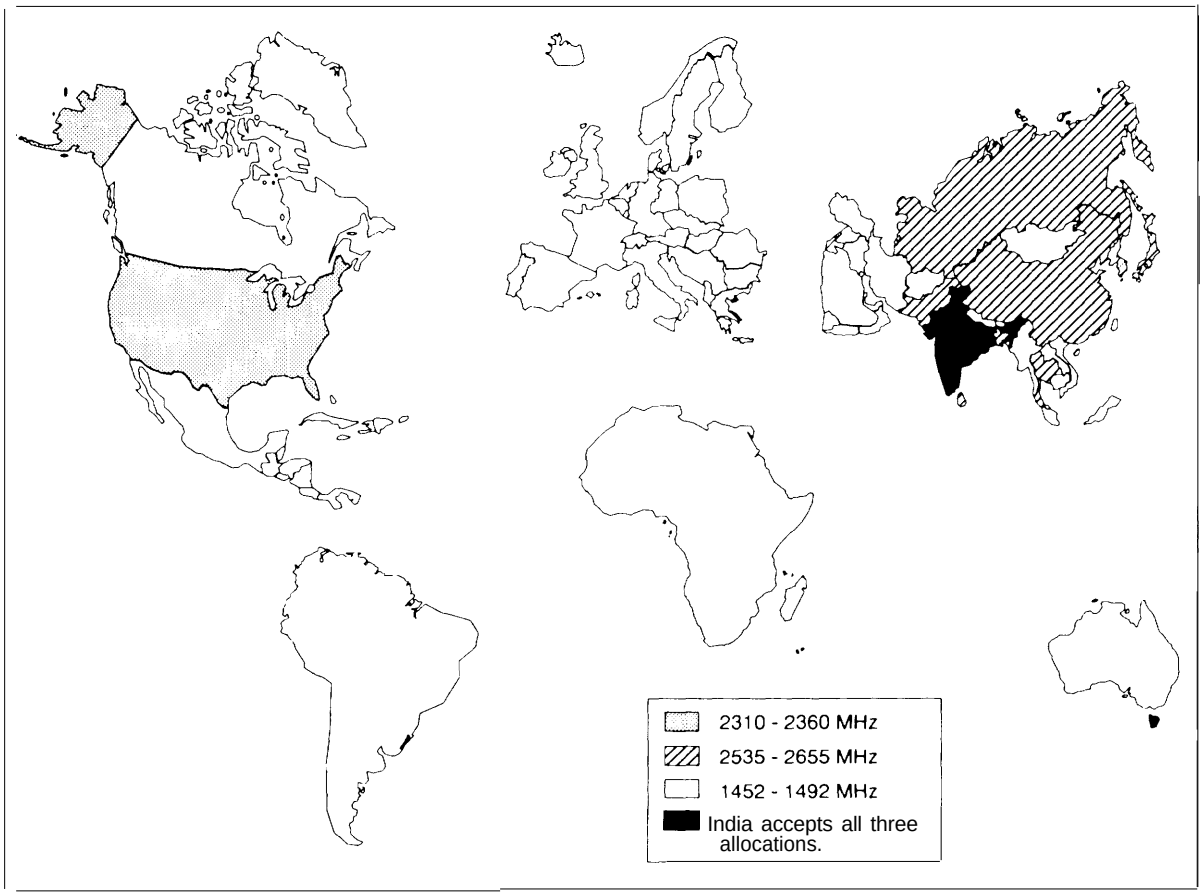
Because of the contentious nature of the debate in this country over allocations for BSS-Sound, the U.S. proposal for this service was submitted to the ITU after the formal package of U.S. proposals was submitted in July 1991. The United States proposed that the 2310-2360 MHz band be allocated for BSS-Sound and complementary terrestrial broadcasting services on a worldwide basis.

## Results

The U.S. proposal was not adopted as a worldwide allocation. Instead, WARC-92 adopted three different allocations for BSS-Sound (see figure 2-2 and table 2-2), making the development of a common worldwide BSS-Sound system/ standard unlikely.[25] First, WARC-92 allocated 40 MHz of spectrum for BSS-Sound and complementary terrestrial systems at 1452-1492 MHz on a coprimary worldwide basis. However, 30 countries, including many countries represented by the Conference of European Postal and Telecommunications Administrations (CEPT), indicated through a footnote (722AAA) that BSS-Sound services will have to operate on a secondary basis until April 1, 2007. This will likely preclude the introduction of these services in those countries until that date. In addition, the United States, holding to its original proposal, added a footnote (722B) that allocates the 1452-1525 MHz band only to the fixed and mobile services-no BSS-Sound or terrestrial DAB services will be permitted in that band in this country. The United States was the only country that made such a stipulation, which was to protect existing aeronautical telemetry users. Second, a number of countries, including Japan, China, and the Russian Federation, allocated (through footnote 757A) the 2535-2655 MHz band for BSS-Sound on a coprimary basis. Finally, the United States, joined only by India, inserted another footnote (750B) allocating

[25] WARC-92 did agree that all BSS-Sound systems would be required to use digital transmission technology.

**Figure 2-2—WARC-92 Allocations for Broadcast Satellite Service-Sound**




**NOTE: Only Belarus, Russia, and Ukraine are included from the former Soviet Union.**

**SOURCE: Office of Technology Assessment, 1993.**

the 2310-2360 MHz band for BSS-Sound, Thus, there are three BSS-Sound allocations that could eventually be used.

WARC-92 also adopted two resolutions pertaining to BSS-Sound. Resolution 528 called for another conference, preferably before 1998, to plan BSS-Sound services, develop procedures to coordinate BSS-Sound with complementary terrestrial (DAB) services, and review criteria for sharing the spectrum with other services. In the interim, new BSS-Sound applications may be implemented, but only in the upper 25 MHz of the allocations, and only according to existing coordination requirements. Terrestrial DAB services

**Table 2-2—Population Distribution of WARC-92 BSS-Sound Allocations**

| Allocations | Population (milllions) |
|---|---|
| **1452-1492 MHz** | **3,135** |
| **No restrictions** | **2,584** |
| **Not until 2007** | **551** |
| **2310-2360 MHz** | **1,087** |
| **2535-2655 MHz** | **2,719** |

**NOTE: Because India accepted all three allocations, the actual numbers of listeners for each allocation will vary depending on which allocation(s) India uses.**

**SOURCE: Office of Technology Assessment, 1993, based on** data **provided by Voice of America.**

may also be introduced, but only after coordinating with countries whose existing services might be affected. This 25 MHz limit should allow some services to use the spectrum, but the number of systems that could share the frequencies may be limited.

Resolution 522 notes that BSS-Sound services could be provided by either geosynchronous or non-geosynchronous orbit satellites, and requests that the CCIR study the sharing criteria for BSS-Sound systems using different orbits and between BSS-Sound and other services in order to develop coordination procedures and avoid harmful interference between systems and services.[26] The resolution also requests that the ITU's Administrative Council place this matter on the agenda of a future WARC. This resolution responds to the development of low-Earth orbiting satellite (LEOS) systems and the many unknowns regarding systems using this new technology.

WARC-92 also adopted Resolution 527, which calls for a future WARC to consider the development of terrestrial DAB in the VHF broadcasting bands (existing FM radio bands) for Region 1 and interested countries of Region 3. This is in response to the plans of several European countries to begin digital sound broadcasting on an interim basis in those bands. The resolution also requests the CCIR to begin the relevant technical studies (including system characteristics, propagation, and sharing criteria) associated with the introduction of such services.[27]

## Discussion

The idea of broadcasting radio programming directly from satellites is not new, dating back at least 45 years.[28] The introduction of digital technology, however, and the promise of static-free radio programming gave new impetus to BSS-Sound and DAB development efforts in the 1980s. The European Commission took the lead in developing digital radio technology with its Eureka 147 DAB project, which was first demonstrated at the 1988 WARC. U.S. efforts to develop DAB and BSS-Sound technology have lagged behind European efforts, and U.S.-developed systems are only now being demonstrated.

### DOMESTIC BACKGROUND

The development of DAB systems has taken two forms in the United States. Originally, a small number of companies proposed satellite-based (BSS-Sound) systems that would use frequencies in the L-band (roughly 1.4-1.6 GHz) to transmit their programming. Because these types of systems, like Eureka 147, would use frequencies other than the traditional AM/FM broadcasting bands, they are often referred to as 'out-of-band' systems. The first U.S. company to formally announce such a system in the United States was Satellite CD Radio.[29] As currently planned, the Satellite CD system, which was proposed in 1989,

---

26 In this case, non-geosynchronous orbits refer primarily to elliptical, and not low-Earth orbits. Because LEOS only remain in range of a receiver for a period of minutes, some analysts doubt whether audio services could be provided by LEOS.

27 International Telecommunication Union, *Final Acts of the World Administrative Radio Conference (WARC-92)*, provisional version, Malaga-Torrernolinos, Spain, March 1992, p. 116. Hereafter, ITU, *Final Acts.*

28 The concept of using satellites to transmit programming was presented by Arthur C. Clarke in 1945 (Arthur C. Clarke, "Extra-Terrestrial Relays," *Wireless World*, October 1945). The more modem concept of BSS-Sound was considered at previous WARCs in 1979, 1985, and 1988. See OTA, *WARC-92*, op. cit., footnote 15.

29 At about the same time, Radio Satellite Coloration (RadioSat) designed a system that would have used the MSAT system planned for operation by American Mobile Satellite Corp. (AMSC) and the Department of Defense global positioning system. The system planned to provide entertainment, communications, and navigation services primarily to car radios on a nationwide basis. Services to be delivered included: interactive digital audio entertainent; data broadcasts, including traffic and weather advisories; navigation information; and two-way voice and data communications. Because of what RadioSat terms "unlawful' behavior on the part of AMSC, RSC was never able to negotiate for frequencies with AMSC and has terminated development of the RadioSat system. RSC has filed suit against AMSC charging violations of the Communications Act of 1934 and the Sherman Antitrust Act.

would use two satellites to broadcast up to 30 channels of CD-quality music to subscribers who would pay a $5 to $10 monthly fee. The system, which will serve only the United States, is scheduled to begin operation in 1997. In December 1992, five other companies submitted applications to the FCC to offer satellite radio services—American Mobile Radio Corp. (a subsidiary of the American Mobile Satellite Corp.), Primosphere L. P., Loral Aerospace Holdings, Inc., Sky-Highway Radio Corp., and Digital Satellite Broadcasting Corp.[30]

Because out-of-band DAB solutions would create a completely new set of radio broadcasting frequencies, many broadcasters have strongly opposed the development of such systems, claiming that they would destroy the American tradition of local broadcasting. Primarily, these broadcasters fear the competition that a national radio service might pose to their local operations. New national radio programs could conceivably take away listeners and advertising revenues that would otherwise go to support local broadcasters.

In addition, broadcasters believe that the more rapid development of out-of-band DAB might put them at a technical disadvantage in using digital technology. To counter these perceived threats, broadcasters have demanded guaranteed access to any new spectrum that would be opened for terrestrial (out-of-band) DAB use.[31] Although no frequencies have been allocated specifically for terrestrial DAB, the FCC did allocate frequencies for BSS-Sound (satellite use only) at 2310-2360 MHz. However, the problem of allowing existing users access to new frequencies will recur if the United States considers additional allocations for terrestrial systems (see below).

Largely in response to local broadcasters' concerns, several companies began developing DAB technology that would work "in-band"—using the same frequencies now used by existing AM/FM radio stations. Such systems would allow terrestrial broadcasters to upgrade their facilities to digital quality at less cost than out-of-band solutions and with minimal disruption to the industry. Today, almost all U.S. terrestrial DAB development remains focused on in-band solutions.[32]

Gannett, CBS, and Group W Broadcasting, for example, formed a partnership (USA Digital Radio) to develop an in-band, DAB system dubbed Project Acorn. This system would send the digital audio signal over the same channel as the existing AM/FM analog signal, but at a reduced power level that would not interfere with the simultaneously transmitted analog signal (see figure 2-3). Demonstrations of the system were scheduled for the end of 1992, with an experimental system planned for mid-1993.[33] Another DAB solution has been proposed by Strother Communications and Lincom Corporation. The Strother/LinCom solution is also in-band, but broadcasts the digital signal in "guard bands''-fiequencies on either side of existing FM channel that are left unused in order to guard against interference from stations on adjacent channels. The system also sends a digital signal that is much weaker than the

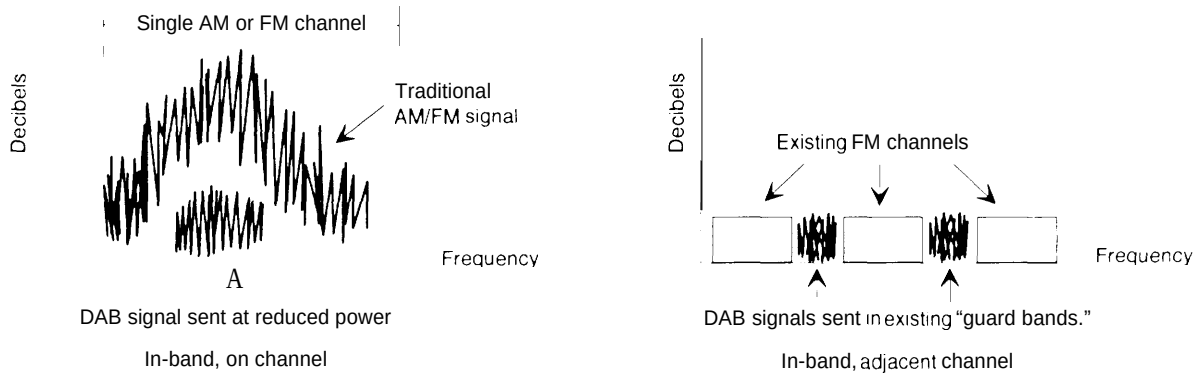
30 These applications were tentatively accepted by the FCC in March 1993, ''FCC Accepts Satellite DARS Application, " *Telcom Highlights International, vol.* 15, No. 10, Mar. 10, 1993. Later in March, Loral Aerospace withdrew its application as part of an agreement to enter into a partnership with Satellite CD Radio.

31 Originally, before in-band DAB systems were being developed, L-band frequencies were considered for both satellite and terrestrial DAB. Broadcasters wanted their access to these frequencies guaranteed so that they could compete in digital services with any new competitors-otherwise they feared they would be effectively shut out of and unable to compete with the new technologies and services. This situation is analogous to the current demands of cellular carriers to be allowed to provide personal communications services.

32 Edmund L. Andrews, "Digitat Radio: Static Is Only Between Owners," New *York Times, May 6, 1992,* p. D8.

33 Daniel Ehrman, Vice President, Finance and Business Affairs, Gannet Broadcasting, personal communication, June 2, 1992.

**Figure 2-3—Proposed In-band Digital Audio Broadcasting Systems**




SOURCE: Office of Technology Assessment, 1993.

analog signals in order to avoid interference. Other companies developing terrestrial DAB systems include Mercury Digital, AT&T, the Massachusetts Institute of Technology and General Instrument.

### WARC PREPARATIONS

The development of a proposal for BSS-Sound was the most difficult in the domestic WARC-92 preparation process.[34] Many interest groups in both the private sector and the Federal Government took strong positions on the issue, The majority of the private sector, as indicated by the FCC in its Report on WARC-92, favored an allocation for BSS-Sound in the L-band (between 1430 and 1525 MHz), as did many foreign countries.[35] The U.S. aerospace industry, the Department of Defense and its aerospace contractors and many local terrestrial broadcasters resisted this proposed allocation. Aerospace industry representatives, both civilian and military, vehemently oppose any new use of the L-band, due to its importance for aircraft and weapons systems testing and the unknowns associated with developing a new radiocommunication service/system.

During WARC-92 preparations, the U.S. broadcasting industry was tom by bitter internal disagreements over the future development of DAB and the U.S. BSS-Sound proposal. Proponents of satellite-delivered DAB favored frequency allocations in the L-band. Initially, the National Association of Broadcasters (NAB), which represents local broadcasters, supported this approach. However, a significant number of local broadcasters strenuously opposed the allocation of radio frequencies for a new satellite audio broadcasting service, arguing that many local broadcasters were already experiencing financia1 difficulties and that the establishment of a competing, national service would undermine the ability of local broadcasters to attract advertising revenues. In January 1992, the NAB dropped its support for L-band proposals. Eventually, the opponents of an L-band allocation prevailed, and a compromise allocation was proposed at 2310-2360 MHz.

---

34 See OTA, *WARC-92*, op. cit., footnote 15.

35 This band is currently allocated in the United States to mobile (shared by both Federal Government and nongovernment users, but limited to aeronautical telemetering and telecoremand of aircraft and missiles), radiolocation (for military use only), and freed services (allocated on a secondary basis for government use only). The S-band is not as extensively used for aeronautical telemetry as is the L-band.

### WARC NEGOTIATIONS

**At WARC-92, the** U.S. proposal has been described as 'dead on arrival. ' There was almost no international support for this allocation going into the conference, and despite the best efforts of U.S. negotiators, only India supported the U.S. position in the Final Acts of WARC-92. Opposition to the U.S. proposal came from all parts of the world. Canada, for example, has been developing terrestrial DAB systems that would use L-band frequencies, and Mexico has indicated that it will develop similar systems in the next several years. The CEPT countries also opposed the U.S. proposal, initially proposing allocations in the 2570-2620 MHz band, and later supporting allocations in the L-band.[36] Other countries, including China, Japan, and the Russian Federation favored an allocation around 2500 MHz, in order to protect their existing uses of the L-band.

At the conference, the primary debate was over where the BSS-Sound allocation should be located-in the L-band (1.5- 1.6 GHz) or the S-band (2.0-2.5 GHz). The debate was difficult because each band has specific advantages and disadvantages.[37] Discussion focused on questions of technology (propagation), economics (cost of receivers), but more practically on the politics of spectrum management—the tension between protecting existing services on the one hand and promoting new technologies and services on the other. L-band allocations were opposed by many countries, including the United States, Japan, and some European countries, because the bands are already heavily used for other radio services. In Japan, the bands are allocated to important mobile services. In the United States, the band is used for aircraft and weapons testing. Moving these existing users to other frequencies would cost millions of dollars.

### POST-WARC ACTIVITY

**Since WARC-92** ended, BSS-Sound and DAB regulatory and development efforts in this country have been moving slowly, largely due to the ''wait-and-see' strategy the FCC and NAB pursued immediately following the conference. However, the FCC has taken several actions in the DAB/BSS-Sound debate. In October 1992, the FCC proposed to allocate the 2310-2360 MHz band for BSS-Sound (but only for satellite use) in this country, a decision that was later formalized. This action boosted the prospects of Satellite CD Radio, and, as noted above, prompted other companies to enter the race for BSS-Sound. The FCC's allocation, however, has not dampened the development of in-band, terrestrial DAB systems.

Ironically, the allocations made by WARC-92, and the obstinate U.S. position on L-band, have focused more attention on in-band DAB systems in the United States. Initially, most of the private sector favored an allocation in the L-band.[38] When that band was not allocated in this country, attention shifted to in-band solutions, which had become better defined as the WARC preparations process went along. Several companies are now developing in-band DAB systems, including those noted above.

Regarding satellite DAB, NAB opposed a Satellite CD Radio request for an expedited FCC rulemaking to allocate the 2310-2360 MHz band for BSS-Sound, stating that the world course for digital radio, satellite and terrestrial, remains unclear.[39] At the same time, NAB encouraged the development of an in-band system for DAB that

---

36 A total of 18 CEPT countries jointly submitted the CEPT proposal.

37 Most BSS-Sound proponents and radio engineers believe that the frequencies around 1.5 GHz are technically better suited fOr satellite-delivered DAB than higher frequencies. Propagation characteristics are better at L-band-at the higher S-band frequencies, signals are more likely to be scattered or blocked by buildings, trees, etc. Because of this, some analysts believe that S-band may only be suitable for satellite transmission.

38 See especially Annex B of Industry Advisory Committee, "Final Report: WARC'92,'' submitted to the FCC, Apr. 30, 1991.

39 ''NAB Opposes Satellite CD Radio Request for Expedited BSS-Sound Allocation Rulemaking,' *Telecommunications Reports,* June 8, 1992, p. 30.

would improve the quality of both AM and FM stations. If that effort was to fail, NAB apparently believes that L-band is more attractive for BSS-Sound than the S-band allocation the U.S. indicated at WARC-92.

The Electronic Industries Association (EIA) established a task group in August 1991 to develop a standard for DAB in this country. The standard agreed to by EIA will be submitted to the FCC as a proposed U.S. standard. The group is composed of specific system proponents, broadcast representatives, and manufacturers. In late 1992, the group solicited proposals for systems to be tested as part of the recommendation process, and actual testing of proposed systems is scheduled to begin sometime in 1993.[40]

Internationally, the United States continues to be active in the work of the CCIR'S study group on BSS-Sound issues. In preparation for future CCIR meetings on BSS-Sound, industry and private sector representatives formed a working group in August 1992 to develop U.S. positions. The main focus of the group will be on future topics the CCIR should study in preparation for the future radio conference on DAB called for in Resolution 528.

A few companies have been authorized to provide BSS-Sound services in other parts of the world. The first, WorldSpace Corp. (Afrispace, Inc.), was granted an experimental license by the FCC in 1991 to provide radio services in Africa. After regulatory delays resulting from WARC-92, Afrispace now plans to launch its AfriStar-1 satellite in 1995, and has signed up 3 broadcasting companies that will use 5 of its 36 channels.[41] CaribSpace Ltd., a subsidiary of WorldSpace, has been granted a license from the government of Trinidad and Tobago to provide similar services in the Caribbean.[42]

## Issues and Implications

The questions involved in assessing the future of BSS-Sound and DAB far exceed the allocations issues debated at WARC-92. The allocations made at the conference set the stage for the future development of new digital radio services, but the allocations are only one part of a much larger constellation of policy problems related to the future development of radio technology and the evolution of the radio broadcasting industry in this country. The decisions to be made about how to implement WARC-92 allocations implicitly shape future, broader policy decisions, and cannot be considered separately from them.

The case of BSS-Sound/DAB represents a missed opportunity for the United States. Based on the reported needs and requirements of the Defense Department and its (politically) powerful allies in the aeronautical telemetry industry, and pressure from the Secretary of Defense, the United States was forced to take a position counter to the majority of the world. The problem is not that the Department of Defense won, ' but rather that the (policy) process for determining needs and evaluating competing needs was largely hidden from view. What should have happened was an objective and thorough review of the existing use of the band compared with the potential benefits to American industry, leadership, and consumers of participating in a new worldwide broadcasting system.

The extent to which this was done is unclear. NTIA officials maintain that proper policy procedures were followed and that L-band allocations for BSS-Sound were not pursued because support for the concept and those particular allocations was weak. However, it is difficult to discern in this case if there was a formal policymaking process, and if it was followed. Because of the sensitive nature of the bands involved and the

40 Steven Crowley, consulting engineer, personal communication, July 6, 1992.

41 Daniel Marcus, ''AfriSpace Satellite Plan Runs Into 2-Year Delay,'' *Space News, vol.* 4, No. 2, Jan. 11-17, 1993.

42 *Telecommunications Reports, ''CaribSpace* Gets License for Satellite Radio System From Trinidad and Tobago Government' vol. 58, No. 36, Sept. 7, 1992.

closed nature of the IRAC process, it is impossible to determine how thorough and objective the evaluation of the competing uses of the band was. Questions remain about who did the comparing, what factors they used (and how each was valued), and what inputs were considered from both sides.

The stakes in the BSS-Sound debate are too important to let things develop without further policy analysis and debate. Mexico, and especially Canada, are planning to move ahead with (terrestrial) DAB plans in the next several years. Meanwhile, the United States risks falling behind in this potentially lucrative opportunity for U.S. manufacturers and service providers and this potentially important method for disseminating U.S. programming and information overseas. The consequences are clear:

> If DAB is established internationally years prior to introduction in the United States, our international competitiveness would be put at risk while the public would be denied access to an important new service.[43]

## DOMESTIC ISSUES

After a less-than-satisfactory outcome at WARC-92, domestic efforts to develop BSS-Sound and DAB continue. The United States, because of its existing use of the L-band spectrum and its strong tradition of local broadcasting, has been forced into a dual approach to DAB development. This dual approach is shaped in part by history and in part by technology, which has become an important driver of the DAB/BSS-Sound debate. Some companies are concentrating on developing in-band systems for terrestrial use while others are focusing on satellite-delivered out-of-band systems. No system currently being developed effectively integrates existing broadcasting infrastructure with new satellite technology.

This divided approach reflects the two perspectives that drive the BSS-Sound/DAB debate. On the one hand, many people raised in the traditional broadcasting industry tend to see the issue as one of new satellite services versus traditional local broadcasters. This group is most concerned with developing terrestrially-based DAB solutions that will preserve the existing radio services and industry structure while bringing technical innovation to the industry. On the other hand, the proponents of satellite-delivered DAB have a slightly different set of concerns than the broadcasters. They are most concerned with bringing new services to the public and making a range of broadcasting services available to previously underserved areas.

The allocations made by WARC-92 and U.S. response(s) to them confined this duality. This *de facto* approach was not the result of any carefully thought out policy initiative to improve U.S. radio quality or diversity, but rather an attempt to avoid hard choices by letting marketplace forces decide a technology "winner." Unfortunately, this tactic has slowed the development of DAB technology, and may prevent the United States from entering this new field early on—allowing other countries to develop the expertise, hardware, and software that will make them the leaders in this new technology/service area, not the United States. This unofficial strategy has important long-term consequences for the future of the broadcasting industry in the United States, and it is unclear whether U.S. policymakers recognize, and are willing to confront, the many factors at work. To date, the larger issues of how these new digital technologies will impact the future (and structure) of the radio broadcasting industry in this country have been ignored by policymakers.

Short-term Issues--The most immediate question facing U.S. policymakers and regulators is how future digital radio services will be offered. The FCC has taken the first step toward defining the future of radio broadcasting in this country by

---

[43] Testimony of John R. Holmes, in Hearings before the Subcommittee on Telecommunications and Finance of the Committee on Energy and Commerce, House of Representatives, 102d Congress, Nov. 61991, p. 8.

adopting the allocations the United States pursued at WARC-92. Other issues that remain to be resolved include how many competing BSS-Sound systems could the U.S. population support? Will these competing systems share listeners, or will subscribers be locked in to one provider? Should other ways of providing BSS-Sound services, such as advertiser-supported, nonprofit, or public broadcasting, be encouraged, and how can this be done? Should future terrestrial DAB services use the same band as satellite, or should they use the existing AM/FM band?

For example, the development of in-band systems poses several issues for policy makers. One concern is the distinction between AM and FM broadcasters. Because of the differences in spectrum currently allocated to AM and FM stations (10 kHz vs. 200 kHz, respectively), developing in-band digital solutions for FM radio has been much easier than for AM. Because of this, many industry analysts expect that AM DAB will not be able to achieve the same quality as FM DAB.[44] Due to such predictions, some AM station owners have promised to block any standard that disadvantages them relative to FM. On the other hand, FM station owners will resist any technology that brings AM radio broadcasting up to the quality of FM and hence into more direct competition.[45] Some observers believe that such feuding among broadcasters could potentially slow the development of terrestrial DAB technology, and cause the United States to fall (further) behind in the development of such technologies and systems—reducing or removing any chance the United States may have to be a world leader in the production of DAB equipment and the operation of DAB services.

Alternatively, if future *terrestrial* DAB services are allocated (additional or alternative) spectrum outside the traditional AM/FM bands, future licensing of such systems would pose the FCC with a challenge similar to the decision facing it in the personal communication service (PCS) licensing proceeding.[46] Should existing broadcasters be allowed into new spectrum to offer DAB, or should this new spectrum be opened only to new service providers? This is more than a technical or economic question, which will require the FCC, with the input of the Congress, consumers, and industry to decide.

Long-term Issues-Such issues indicate a number of longer-term questions for regulators and policymakers. Should all broadcasters have an equal shot at DAB technology? How can new forms of competition in radio services be promoted while acknowledging (but not necessarily protecting) the role and investments of local broadcasters? How can the traditional strength of the U.S. local broadcasting industry be complemented by the new technologies of satellite delivery? What should the future structure of the U.S. broadcasting industry look like?

The most difficult long-term issue facing policymakers is how BSS-Sound and DAB will affect the (local, terrestrial) broadcast industry. Satellite broadcasting directly to listeners has the potential to dramatically reshape the broadcast industry in this country. Depending on a number of technical, economic, and political choices that will be made in the next several years, BSS-Sound services could complement local program-

W Edmund L. Andrews, op. cit., footnote 32.

45 The issue is money. Over the years, FM radio &gained popularity over AM because of its higher quality. As a result, more people listen to FM stations, and licenses for FM stations are more valuable. Digital technology, with its immunity to noise and high quality, would wipe out the differences in quality between AM and FM stations: Bringing all stations into quality parity and bringing down the value of FM licenses will at the same time raising the value of AM licenses. Broadcasters who have invested hundreds of thousands (or even tens of millions) of dollars in an FM station will oppose anything that would jeopardize that investment.

46 In that case, the FCC must decide whether to allow cellular operators to provide PCS, taking advantage of their technical and marketing experience, or bar the cellular operators from entering the PCS market in order to foster more competition in the mobile services industries.

ming, be limited to serving niche markets, or emerge as a substantial competitor to local broadcasters.

In some countries and in some systems, terrestrial and satellite DAB may develop as complementary parts of one broadcasting system. In the United States, however, it now seems likely that the two industries will remain separate--the established broadcast industry controlling terrestrial DAB, and the new startups controlling satellite services. It is likely that these technologies will continue to develop on separate tracks, although the relative timelines for the development of each is far from certain. This divided approach may prevent the United States from pursuing a comprehensive approach to improving radio broadcasting quality and diversity, while at the same time extending its reach and flexibility. Countries adhering to one (in this case most likely L-band) allocation for both terrestrial and satellite programming may have an advantage in building a more flexible broadcasting system.

As both BSS-Sound and terrestrial DAB systems come into operation, the challenge for the FCC will be to fashion a radio broadcasting industry that takes advantage of both satellite and terrestrial DAB technologies. The question is: Are the services inherently competitors, or could they be (structured to be) complementary? NAB and the local broadcasters tend to see satellite delivery of audio services as a potential competitive threat.[47] However, it may be possible to set the rules for BSS-Sound such that the services are complementary, rather than competitive. A possible analogy may be the dual nature of cable television—local television stations and cable channels exist alongside "superstations" and nationwide cable channels that cater to specific interests. Nationwide services may be able to supplement existing local services or cater to nationwide niche audiences that are too small to support local broadcasting, but when aggregated can support a broadcasting service. Ethnic or religious groups may provide audiences for such programming. Nationwide coverage would also fill in gaps in coverage of various programming formats-not every person in America can get the kinds of radio station he or she wants, and not every market has 10, 15,20 or more stations with a variety of formats available. For the more remote listener who would like to hear classical music, a satellite-delivered service may be the only real option.

Industry fears that nationwide satellite audio programming will destroy the broadcasting industry must be taken seriously. However, a larger policy question remains: if the radio industry is doing so poorly—stations closing, revenues dropping-why save it? The industry should be prepared to present a good case for preserving its privileges based not on past history-there can be little doubt of the historical importance of local radio stations, but on the prospects for future performance. Society in the 1990s and beyond is changing rapidly, and the Nation's radio listeners are entitled to a radio system that best meets their needs. The public interest may need to be redefined to include not only local, but also national and international programming g and services.

## INTERNATIONAL ISSUES

**The international** issues surrounding the implementation of BSS-Sound and DAB services are complex, and at present there are more questions than answers about the future of digital radio broadcasting services. As a result, the future of DAB/BSS-Sound and the impacts of the three BSS-Sound allocations is uncertain. Perhaps

[47] They note that if digital-quality satellite services are authorized and made available before local broadcasters can implement terrestrial digital broadcasting systems, this would represent unfair competition. John Abel, for example, stated that some local and satellite services could exist side-by-side, and local broadcasters could compete "if we have the same opportunity as the satellite broadcaster in providing DAB." Testimony of John Abel, in Hearings before the Subcommittee on Telecommunications and Finance of the Committee on Energy and Commerce, House of Representatives, 102d Congress, Nov. 6, 1991, p. 14.

most importantly, until a future conference can be held to plan BSS-Sound, only the top 25 MHz of the allocations can be used to provide BSS-Sound services .48 This effectively means that the number of potential service providers in the band will be very limited, at least until the requested WARC is held.[49] In addition, the entire world, with the exception of about a dozen countries, agreed to the L-band allocation, although in some countries, including most of Europe, the services may not be able to be offered until 2007.[50] Although the United States is not wholly responsible for these outcomes, U.S. actions contributed to an allocation structure that is less than ideal from a global service perspective. The division of the world into three different BSS-Sound allocations could have a number of detrimental effects on the future of the BSS-Sound industry.

Manufacturing—From a manufacturing standpoint, multiple allocations mean that makers of portable radios and radios for cars will be forced to build three different types of receivers. Although the different radios may share some common parts, the radio receiving equipment will have to be different. And if different formats and standards are used for the transmission of DAB, manufacturing difficulties will become even more severe. The division of allocations and possibly standards will lead to production that is not as efficient since manufacturing efforts will have to be divided.

For the United States, the impacts of this division on manufacturing will be limited since ''there is almost no production of VCRs, camcorders, tape players and recorders, radios, phonographs, or CD players in the United States."[51] The impacts on the makers of radios for U.S. cars, GM-Delco, for example, is also likely to be slight. It remains to be seen if domestic manufacturers will produce alternative radios for installation in vehicles destined for export. Development of a strong domestic BSS-Sound industry, however, could enhance and expand this country's reputation as a leader in the development and operation of satellite communications systems. The actual benefits of this new technology for the United States, however, are less clear, since the technical details of U.S.-designed and built systems would have to be modified to work in other parts of the world.

International Broadcasting—The impacts of multiple allocations on international broadcasting are likely to be more severe. Because up to three sets of frequencies could be used for BSS-Sound around the world, the development of a global satellite radio broadcasting service will be difficult. Instead, regional BSS-Sound systems are likely to become the focus of development efforts, and coordination between countries using different allocations could be difficult.[52] The United States, for example, is expected to have a hard time coordinating its aeronautical telemetry servi-

48 See Resolution COM4/W, ITU, *Final Acts*, op. cit., footnote 27. In the final numbering of Resolutions and Recommendations, COM4/W became Resolution 528.

49 The Satellite CD Radio (SCDR) system, for example, uses 21 MHz of spectrum, but can only share with one other operational system. The plan proposed by SCDR would accommodate up to eight satellites (approximately 4 competing providers), but would use the whole 50 MHz of the U.S. 2310-2360 MHz allocation. Cutting the available spectrum in half would presumably limit the number of competing providers to two.

50 Numbers of countries per allocation, however, is only one indication of the potential impacts of these allocations. When judged (roughly) by population served by each allocation, the disparity between allocations lessens significantly (see table 2-2). L-band allocations could serve up to 3,2 billion listeners, the U.S./India allocation up to 1.1 billion, and the other S-band allocation up to 2.7 billion. These numbers are changeable because India, with over 800 million people, accepted all three allocations. Figures are based on numbers provided to OTA by the Voice of America.

51 U.S. Department of Commerce, International Trade Administration, *U.S. Industrial Outlook* '92 (Washington, DC: U.S. Government Printing Office, January 1992).

52 However, from a hardware/system perspective, the impacts of this division will be limited since satellite systems are already routinely designed to serve regional areas.

ces—testing for (military) aircraft and weapons systems—with Canada and Mexico. These countries plan to use the worldwide allocation to provide DAB services, although initially only through terrestrial transmission systems. This means that Canadian and Mexican L-band systems will have to be coordinated with U.S. aeronautical telemetry users, and any U.S. system that is deployed using the S-band allocation will have to be coordinated with Mexico and Canada. It is possible that this will put pressure on the government to simply drop the U.S. position on L-band and adopt the world allocation.[53]

In addition, an important issue in the implementation of BSS-Sound systems, especially in the area of new entertainment and information services, is the question of cross-border information flows. Because of the nature of satellite transmission, it is very difficult to limit a satellite's signal (its footprint) to conform to national boundaries. Some countries may resist (or jam) unwanted transmissions from outside their borders. WARC-92 did not address this question, since the primary focus of the meeting was to agree on allocations for the service. However, it is expected that a future conference will take up the issue.[54]

For U.S. international broadcasters who see BSS-Sound as a way to extend their coverage and give their listeners higher quality, the impacts of different allocations are unclear. Any international broadcaster that decides to put up its own satellite system to achieve worldwide coverage will have to adapt its satellites and its system design to conform with the varying allocations. It is also possible that international broadcasters could lease transponders on regional systems—this would relieve them of having to engineer their own system, but would also relinquish their direct control of their transmissions.

Listeners--Finally, the impacts of different BSS-Sound allocations on listeners are likely to be minimal, except for international travelers. Common allocations and equipment have benefited consumers in the past because they can use their radios anywhere in the world-current broadcasting frequencies are global, and AM and FM are standard modulations schemes. When BSS-Sound systems come into operation, listeners will have to buy new DAB-compatible radios, which will be slightly different depending on where they live.

The cost for DAB/BSS-Sound receivers is expected to follow the example set by other consumer electronic technologies-it will likely start out very high initially, but fall quickly as demand improves and mass market economies are achieved. Most analysts expect the cost of such receivers to be no more than high-end AM/FM cassette players available today. The cost for a radio station to upgrade its facilities in order to offer DAB programming is less clear. The cost in this case will depend on how advanced/up-to-date the station's existing technology is—is there a lot of equipment that must be changed out, or does the station already have some of the digital equipment necessary to

---

53 The initial terrestrial focus of the Canadian and Mexican systems may be a blessing for the United States. Terrestrial systems will be easier to coordinate than satellite systems since their limited range means they will affect U.S. telemetry operations only near the borders. Eventually, however, these systems may also be delivered via satellite, at which time coordination and interference problems will become much more difficult. Some observers note that the introduction of satellite DAB services in Canada and Mexico would seriously degrade aeronautical telemetry services, perhaps making them unworkable. The long transition time to sateUite-delivered DAB services, however, should provide adequate time for U.S. telemetry operations to move to higher bands. Another serious concern in the implementation of these systems is their effect on U.S. radioastronomy activities, which use very sensitive receivers in the frequencies just below those now allocated for BSS-Sound.

54 Resolution 527 takes note of the problem by noting No. 2674 of the Radio Regulations, which states: ''In devising the characteristics Of a space station in the broadcasting-satellite service, all technical means available shall be used to reduce, to the maximum extent practicable. the radiation over the territory of other countries unless an agreement has been previously reach with such countries. ' ITU, *Radio Regulations,* p. *30-2,* op. cit., footnote 19.

support DAB operations? Estimates range from $50,000 to $150,000.55

One important policy consideration, in this country and internationally, is to lay out a realistic transition plan that will allow a smooth and orderly phase-in of terrestrial and satellite DAB service in whatever band(s) are used. Following past practice, for example, new DAB radios may be required to be able to receive regular AM/FM transmissions.

## TERRESTRIAL MOBILE SERVICES

The mobile telecommunications service industry is still in its formative stages—mobile and mobile-satellite technologies continue to evolve and new systems are proposed regularly.[56] Because of this volatility, it is difficult to predict what the industry will look like in 5, 10 or 15 years. Different proponents have different perspectives on the future of mobile services, and no one really knows yet how the pieces will fit together. The final structure of the mobile services industry will depend largely on market forces. Consumers will decide which services—satellite, PCS, cellular, mobile data—will be successful and which will not.

One of the fastest-growing segments of the mobile telecommunications industry is terrestrially-based radio systems serving mobile users (in cars, trucks, ships, aircraft, and on foot). Since its introduction in 1983, for example, cellular telephone service has amassed more than 9 million subscribers in the United States, and recent statistics released by the Cellular Telecommunications Industry Association show an annual growth rate approaching 40 percent.[57] Some estimates of the potential revenues from mobile services run into the tens of billions of dollars annually.[58]

The boom in demand for mobile telecommunications services has given rise to a confusing array of new technologies and systems. Countries and businesses around the world have proposed new mobile applications that will deliver a wide variety of new (and old) services, including paging and messaging, telephone, facsimile, data communications, and even imaging and video. In the United States, for example, hundreds of companies have applied at the FCC for radio frequencies to deliver future PCS.[59] In Europe and Japan, government authorities have given mobile services high priority in domestic spectrum allocations. As a result of the growing demand for services and spectrum, WARC-92 was charged with allocating additional spectrum for new and emerging mobile services.

### Future Public Land Mobile Telecommunications Systems

#### BACKGROUND

The focus of WARC-92'S attention to mobile services was on Future Public Land Mobile Telecommunications Systems (FPLMTS).

55 Testimony of John R. Holmes, op. cit., footnote 43, P. 9.

56 In ITT-J parlance, "mobile' refers only to terrestrially-based mobile systems. ''Mobile-satellite service' (MSS) refers to mobile services provided via satellite. MSS is discussed in the next three sections.

57 Breed on statistics compiled in the frost 6 months Of 1992. "CITA's Biannual Survey Shows Record Industry Growth in First Half of 1992," *Telecommunications Reports,* vol. 58, No. 36, Sept. 7, 1992.

58 Studies estimating the potential value of these new markets must be viewed with caution as data and its interpretation is highly subjective. A study conducted by Market Intelligence predicts that worldwide sales of cellular phones, pagers, and accessories will reach $6.2 billion by 1998. "Study Says World Markets for Cellular Phones, Pagers Will Reach $6.2 Billion by 1998," *Telecommunications Reports, VOL 58, No. 37,* Sept. 14, 1992. Another study conducted by Alexander Resources, Inc., for example, puts potential revenues at over $10 billion in 1999 for wireless local exchange services alone. *Telephony,* June 29, 1992, (untitled box), p. 11. A study by Datacomm Research Co. projects potential revenues for cellular data services will reach $1 billion by 2001. ''Datacomm Study" *Telecommunications Reports, vol. 58, No. 36,* Sept. 7, 1992.

59A partial list of the companies that have applied at the FCC to offer such services can be found in OTA, *WARC-92,* appendix C, op. cit., footnote 15.

FPLMTS refers to a concept being developed in the CCIR primarily by European radiocommunication interests for delivering mobile telecommunications services in the 21st century. Although clear service definitions and specifications have not yet been developed, FPLMTS is currently conceived as a terrestrially-based system (perhaps supplemented with satellite technology) using large towers located throughout a region to provide an array of voice, data, and video services to mobile users. The Europeans view FPLMTS as the successor to the Global System for Mobile communications (GSM—formerly Groupe Speciale Mobile)---a pan-European digital cellular system that is currently being deployed across Europe.[60] In order to ensure that future mobile systems would have adequate spectrum, the Europeans pursued allocations for FPLMTS at the 1987 Mobile WARC (MOB-87), but the issue was carried over to WARC-92.

### U.S. PROPOSAL

**The** United States made no specific allocation proposals for FPLMTS, citing the extensive existing allocations available for mobile services, uncertainty over just what FPLMTS is, and the possibility of making FPLMTS-like services available through standard-setting and common (global) interoperability requirements rather than through a new frequency allocation. In its statement on FPLMTS in the official U.S. WARC-92 proposals, the United States noted the work being done to develop FPLMTS internationally, but opposed the allocation of new frequencies for the system(s).

### RESULTS

**WARC-92** did not formally allocate any frequencies for FPLMTS, but it did identify 230 MHz that is 'intended" to be used for FPLMTS—1885-2025 MHz and 2110-2200 MHz. This "identification" was made in footnote 746A—FPLMTS does not appear in the actual allocations table. Debate over whether frequencies would be "allocated," "identified," or "intended" for FPLMTS use was intense (see discussion below). Related to the work on FPLMTS, WARC-92 also upgraded the mobile service to coprimary status (in Region 1) in the 1700-2290 MHz band. This created a primary worldwide allocation for mobile services from 1700 to 2690 MHz.

WARC-92 also adopted Resolution 212, which notes the ongoing study of FPLMTS characteristics and calls on the CCIR to continue its work in order to develop "suitable and acceptable technical characteristics for FPLMTS that will facilitate worldwide use and roaming, and ensure that FPLMTS can also meet the telecommunication needs of the developing countries and rural areas."[61] The resolution does not specify dates for implementation nor any relevant operating parameters. It does, however, identify the frequencies 1980-2010 MHz and 2170-2200 MHz as the bands where a satellite component of FPLMTS is expected to be necessary by the year 2010.

### DISCUSSION

Domestic Issues-The debate over the future of mobile telecommunications services in this country has been as intense as the negotiations in Spain over FPLMTS. In the United States, there are many different visions of the future of terrestrially-based mobile services. Cellular, cable, and telephone companies are all looking toward the next generation of mobile telecommunications, and there is a confusing array of ideas about how these new services will be provided and what applications they will offer. Proponents and

---

60 Although GSM has been plagued with delays relating to standardization of equipment, 17 countries plan to begin offering services in 1992 and have 4 million users in 1994. The completed network is expected to be operational by the late 1990s and have 20 million subscribers by the year 2000. Foreign Broadcast Information Service, *JPRS Report*, Feb. 20, 1992, p. 17; Apr. 3, 1992, p. 20; and Apr. 28, 1992, p. 11.

61 International Telecommunication Union, *Addendum and Corrigendum to the Final Acts of the World Administrative Radio Conference (WARC-92)*, provisional version, Malaga-Torremolinos, 1992, p. 17.

analysts talk about micro-cellular systems, CT-2 (2nd generation cordless telephones), and PCS. In addition to these land-based systems, various satellite systems are being planned to offer an array of data and voice services (see the sections on MSS below).

Much of the debate and development of new mobile communications services in this country has focused on PCS, which many consider the U.S. equivalent of FPLMTS. PCS has emerged as an umbrella term that encompasses a wide variety of systems and services, but basically, PCS is a wireless phone and data service that will allow users to send and receive phone calls and/or messages using small lightweight (and eventually inexpensive) handsets similar to today's cellular phones. Current concepts of PCS systems are as varied as the companies proposing them. Some analysts foresee PCS installations in limited geographic areas such as shopping malls, airports, college campuses, and downtown commercial centers--essentially complementing current cellular systems. Others predict wider uses, including vehicle as well as pedestrian communication. These systems would compete with cellular systems, and have even been considered as an alternative to traditional wired telephone service. The FCC has chosen a broad definition for PCS—referring to it as a "family" of new communication services-in order to not prejudge the outcomes of the various development efforts.[62]

The FCC has two separate proceedings that will affect the future of PCS. These proceedings are now being considered simultaneously. The frost, a Notice of Inquiry on PCS released in June 1990, has been the subject of many comments and an en bane hearing in December 1991.[63] In July 1992, the FCC adopted a notice of proposed rulemaking (NPRM) in this proceeding affirming the need for PCS, proposing allocations for data and voice services, and asking for additional comments on licensing, competition, and spectrum requirements. The FCC deferred action on the frequencies to be allocated to PCS, wanting to gather further comments in the emerging technologies proceeding (see next paragraph).

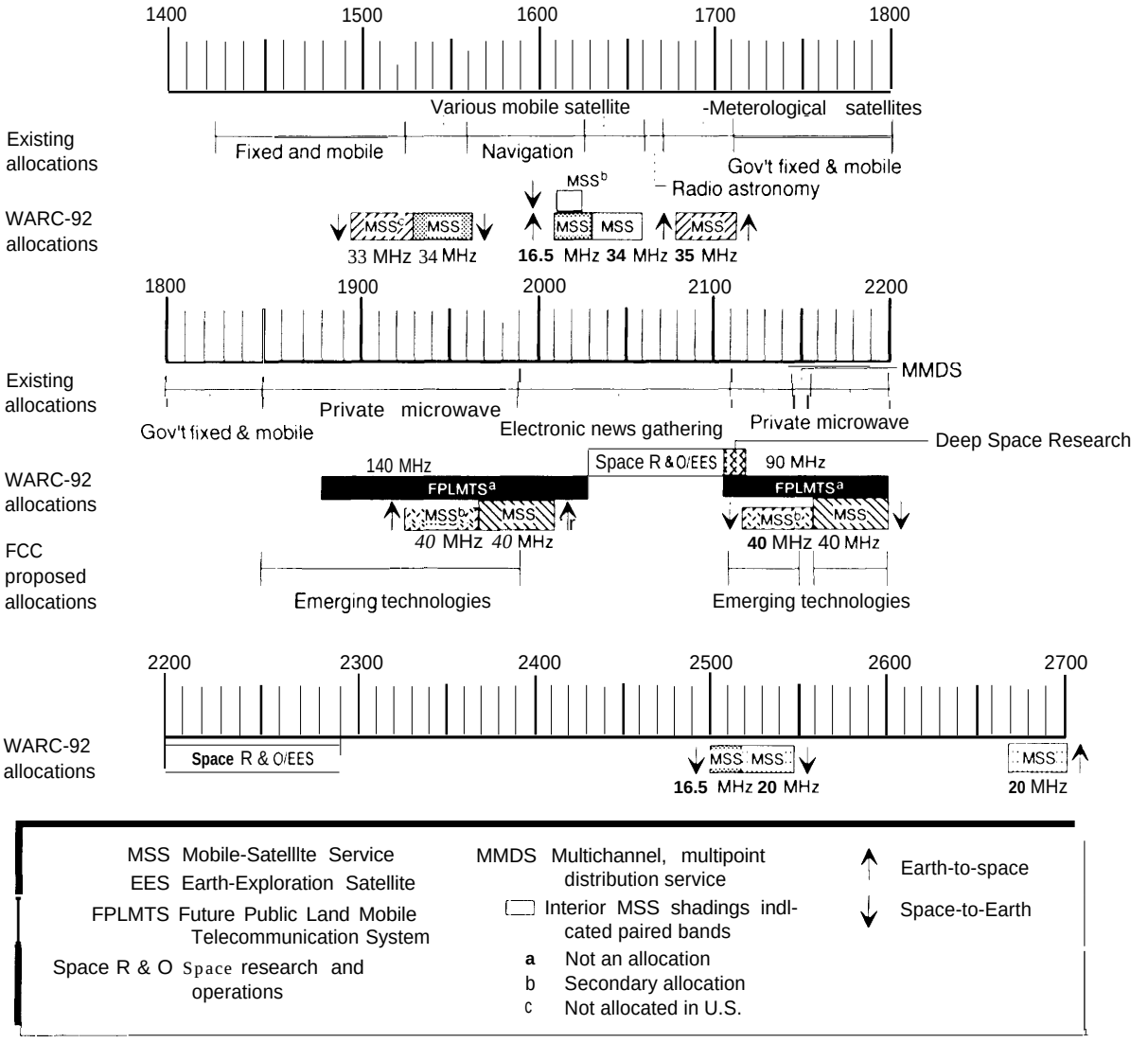
The second proceeding focuses on an FCC proposal to reallocate frequencies in the 2 GHz band in order to create a "spectrum reserve' for emerging technologies.[64] This proceeding was formally begun in January 1992 and in October 1992 the FCC adopted a Report and Order and Third NPRM in the proceeding finally proposing the frequencies to be made available to emerging technologies and outlining transfer plans for incumbent users. PCS is expected to be one of the major users of these bands. All but the lower 35 MHz of this reserve overlaps with the FPLMTS/mobile allocations made at WARC-92, meaning that the FCC could implement FPLMTS/PCS in up to 185 MHz (see figure 2-4). Thus, if a worldwide FPLMTS-like service does develop, the United States will be able to use the same frequencies as the rest of the world. A worldwide primary allocation is desirable because it would make it easier to interconnect various national systems and to develop a worldwide mobile communication system that would allow individuals to use their portable telephones anywhere in the world. Instead of countries using different frequencies for their mobile services, all countries could use the same broad band of frequencies—allowing manufacturers to produce handsets that

62 Cements of Thomas Stanley, FCC Chief Engineer, Feb. 23, 1993.

63 Federal Communications Commission, "Amendment of the Commission's Rules to Establish New Personal Communications Services," *Notice of Inquiry*, Gen. Docket No. 90314, released June 28, 1990.

64 Federal Communications Commission, "R~evelopmentof the Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies, ' *Notice of Proposed Rule Making*, ET Docket 92-9, released Feb. 7, 1992. The FCC proposed to reallocate 220 MHz of spectrum in the 18501990 MHz, 2110-2150 MHz, and 2160-2200 MHz bands. It is important to note the timing of this action-just after the start of WARC-92.

**Figure 2-4—WARC-92 Frequency Allocations From 1400-2700MHz**




**NOTE: This chart is not complete. Not all International Telecommunication Union services are shown, and some have been edited for presentation. Many footnotes will affect the allocations presented. The WARC-92 allocations shown are the allocations as interpreted by the United States, and are not necessarily applicable to other countries.**

**SOURCE: Office of Technology Assessment, 1993, based on a figure supplied by Motorola.**

will work worldwide. Issues regarding standards, protocols, and interoperability between different national systems will have to be negotiated in order to achieve a truly worldwide service.

The FCC's proposal to reallocate frequencies in the 2 GHz band in order to accommodate new technologies has become highly controversial. On one side are the incumbent users of the bands who want to protect their existing point-to-point operations and who would prefer not to move to other frequencies. These users include: the rail-road companies and public utilities--operators of

oil and gas pipelines and electric power transmission lines-which use these frequencies to monitor and control their operations and provide trouble reports during emergencies; public safety agencies-police, fire, and ambulance-which use these frequencies as part of their everyday missions;[65] and common carrier microwave operators who use the frequencies to relay point-to-point communications traffic, often as a backup to long-distance fiber optic lines or to interconnect cellular telephone cells. On the other side are the potential new users of the spectrum, most notably the hundreds of companies that have applied to the FCC to provide new personal communication services. Because of the favorable transmission characteristics of these frequencies, they are ideally suited to delivering these types of new mobile services.

The debate over the FCC's spectrum reserve and its reallocation of the 2 GHz band illustrates the findings and lessons presented in chapter 1. Fundamentally, the debate is one of old versus new—how to balance the legitimate requirements of the existing users against the desire to promote the development of innovative technology systems and services. Each side is able to muster convincing arguments to support its case. The utilities and railroads point to their extensive use of the bands and the important functions that these systems control, especially in times of emergency when reliable and instantaneous communications are vital to control potentially dangerous situations such as power surges, gas leaks, and train derailments. Their systems are often extensive, and have provided reliable communications for many years. Moving to other frequencies, they claim, would create problems because the other frequencies to which they could move are often already crowded, the equipment using those new frequencies is less reliable, and replacing so much equipment would be prohibitively expensive.[66] Changing to other Communication media, such as fiber optics or satellite, often is not possible from an engineering or reliability standpoint, and would cost many millions of dollars.

The proponents of PCS, on the other hand, promise an array of new communication services that would serve millions of users, produce billions of dollars in revenue, and promote the competitiveness of U.S. companies in international radiocommunication markets. They claim that the frequencies allocated to the existing services are not heavily used in all parts of the country and that they can design and engineer their systems to share spectrum where necessary.

Because of the huge financial stakes involved and the potential revenues (and jobs) new services could generate, the FCC's proposal quickly became political. The utilities, feeling that the FCC had not taken adequate account of their views, took their case to members of Congress sympathetic to the concerns of the industry and the public safety agencies. The issue moved beyond technical concerns, and the controversy turned into a political test of wills as much as a debate over technology.

Throughout the dispute, most of the stakeholders indicated that they would be willing to compromise. Utilities and others said they would be willing to share the bands under the right conditions, or they would change frequencies if a suitable transition plan was developed. Their primary concerns were the reliability of the new systems and the cost of moving to other bands. The proponents of PCS indicated a willingness to share the bands and to develop systems that would not interfere with the existing users. They agreed, in principle, to finance the cost of moving the existing users to other bands. Finally, in October 1992, the FCC adopted a decision that

[65] It is important to note that public safety uses would not be forced to leave the band as would the utilities and private/common carrier microwave users.

[66] Estimates vary from $125,000 to $200,000 per channel. See, e.g., "FCC to Delay Proceeding on Highly Controversial Spectrum Reallocation Plan," *Washington Telecom Week, vol.* 1, No. 1, Apr. 3, 1992.

outlined a plan, originally proposed by utility company representatives, for accommodating both interests.[67] The FCC is still collecting and reviewing comments on this issue—no final decision has been reached.

International and WARC-92 Issues-In the past decade, the development of terrestrial mobile communications systems has become a key focus of European telecommunications policy. The geography of Europe-the relatively small size of the countries-lends itself to terrestrial mobile solutions. Satellite systems, on the other hand, cover areas that many Europeans believe are too large for Europe.[68] Issues such as cross-border communications and control of such a network make satellite solutions politically difficult. Despite the drive toward a unified Europe, nations still want to keep some control over their domestic radiocommunication policies, and individual domestic terrestrial mobile systems, even though connected through the umbrella of GSM, fit these needs. As a result, FPLMTS was a key issue for the Europeans at WARC-92. CEPT proposed FPLMTS allocations at 1900-2025 MHz and 2110-2200 MHz.

The FPLMTS debate at WARC-92 presented the United States with a dilemma. It wanted to support the future development of mobile services, and ensure that U.S. PCS services could flourish in the future, but it also wanted to ensure that the spectrum could be used as flexibly as possible, and not be tied to one concept, especially a European concept like FPLMTS. The U.S. position managed to combine the two. Just before WARC-92, the FCC adopted a NPRM proposing frequencies that could be used for emerging telecommunications services such as PCS.[69] The frequencies identified in that NPRM overlapped with the frequencies to be considered for FPLMTS at WARC-92. This action gave the United States an important source of leverage internationally-showing U.S. support for the (international) development of mobile services in the 2 GHz band, but also allowing it to maintain its opposition to explicit allocations for a system that had yet to be defined.

U.S. opposition to formal FPLMTS allocations was based on several factors. First, a large amount of spectrum is already allocated to (terrestrial) mobile services.[70] U.S. spectrum managers believe that such allocations are sufficient to meet future mobile communication needs. Furthermore, U.S. delegates took the position that FPLMTS services could be provided under the existing mobile allocations without setting aside a specific band of frequencies for FPLMTS.[71] In addition, in contrast to the terrestrial focus of the Europeans, U.S. Government and much private sector interest in new mobile services is largely concentrated on satellite-based systems. Satellites are seen as a more efficient way to reach consumers in sparsely populated areas outside the range of terrestrial cellular systems and as a way to allow mobile users to easily ‘‘roam” beyond

---

67 Federal Communications Commission, ‘ ‘Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies,” *First Report and Order and Third Notice of Proposed Rulemaking,* FCC 92-437, Oct. 16, 1992,

68 A satellite beam of only 500 kilometers, approximately what is being described for some LEOS applications, could potentially reach into several countries in Europe.

69 Federal Communications Commission, *Notice of Proposed Rule Making,* Op. cit., footnote 64.

70 The international Table of Frequency Allocations contains a primary mobile allocation in Region 2 in the bands 1668.4-1690 MHz and 17002690 MHz.

71 The formal proposal for FPLMTS states in part that ‘‘tec~~ standards such as modulation p arameters, protocols, and channelization schemes will be just as important as an allocated band in facilitating any requirements for global roaming. These standards and protocols may obviate the need for a common worldwide band for international roaming. We believe that it is premature to designate a frequency band until the CCIR has progressed further in its work. ” U.S. Proposals, op. cit., footnote 5.

72 Presently, a cellular customer who travels outside of his/her local system must often make previous arrangements with the cellular carriers involved and/or dial complex access codes in order to use the systems.

their home system.[72] Finally, the United States opposed specific allocations for FPLMTS because of the lack of a clear definition for exactly what FPLMTS will be. This position is consistent with the general U.S. commitment to keep radio service allocations as flexible as possible so as not to preclude development of innovative new systems and technologies, Allocating spectrum to a service that is currently so poorly defined, and whose spectrum needs are still vague, U.S. spectrum managers believe, would not be an efficient use of the spectrum, and could conceivably lock the world into this inefficient use for many years.

One unacknowledged, although likely, reason for U.S. opposition to FPLMTS is related to trade and competitiveness. The European countries, with GSM, are ahead of the United States in the deployment of advanced digital cellular technologies. American opposition to FPLMTS may represent an attempt by the government and industry to slow down European development efforts in order to allow the United States to "catch up. " Although U.S. technology is second to none, regulatory requirements and the lack of aggressive policy designed to promote U.S. mobile applications has held back the development of a nationwide mobile communications service.

At the beginning of WARC-92, the United States did not support FPLMTS, but did not actively oppose it. U.S. negotiators report they were willing to compromise on FPLMTS in return for concessions by the Europeans on the mobile-satellite service (MSS) allocations the United States wanted for big LEOS and other MSS services. However, as the conference progressed, neither side was willing to compromise much, and negotiating stances hardened. It became clear that U.S. opposition to FPLMTS and European opposition to MSS/LEOS would have to be resolved together. Each side used its opposition to the other's proposal as leverage in the negotiations. Unfortunately, the obstinacy of both sides prevented such a deal from being struck easily.

The final wording of the footnote authorizing FPLMTS caused much debate. FPLMTS proponents urged the conference to ''designate' or "identify" the bands for FPLMTS, but opponents, including the United States, opposed this wording, believing that it was too strong and too closely approached an actual allocation of frequencies for FPLMTS. As adopted, the footnote reads that these bands are ''intended for use. . .by FPLMTS.''[73]

## ISSUES AND IMPLICATIONS

**The** difficulty of predicting the future of mobile services is illustrated by the simple difficulty of even defining what the terms and acronyms mean. The United States, for example, would not support allocations for FPLMTS at WARC-92 because no delegate from Europe could really explain what FPLMTS is. It is a concept, one that has only vague meaning now and will continue to evolve as time passes and needs, technologies, and institutional relationships become clearer.

Although the United States opposed FPLMTS allocations at WARC-92, the outcome of the FPLMTS debate for the United States may, in the long term, turn out to be a "success." The frequencies identified for use by FPLMTS internationally largely match those that have been proposed by the FCC for similar services in this country. Using these frequencies will enable the United States to more easily fit into an international FPLMTS service, thereby opening an important long-term opportunity for the growing U.S. mobile communications industry.

International Issues-The development of terrestrial mobile services in the 21st century is unclear on many fronts. The new technologies and systems for mobile communications are just now being designed and implemented. The European countries have been aggressive in develop-

[73] ITU, *Addendum and Corrigendum, op. cit., footnote 61, p. 17.*

ing and implementing policies that promote the development of new mobile services. As a result, the rollout of GSM, after a slow start, is picking up speed. The European Commission has also issued a directive requiring member countries to allocate spectrum for Digital European Cordless Telephone (DECT) service.[74]

*Regulatory Barriers:* From a regulatory perspective, several issues will confront FPLMTS proponents as they develop systems. First, the ITU has traditionally allocated spectrum only to categories of radiocommunication services, not to specific types of systems such as FPLMTS. Upgrading FPLMTS to a service could be difficult, especially given U.S. opposition. Because the concept of FPLMTS is not well-defined, it is unclear what rights and obligations FPLMTS system operators will have and be subject to. Such legalistic distinctions, however, are not likely to stand in the way of FPLMTS development if no country objects.

Furthermore, the footnote authorizing FPLMTS states that "[s]uch use [for FPLMTS] does not preclude the use of these bands by other services to which these bands are allocated. " How this limitation will be interpreted, and what effect it may have on other services and negotiations among countries remains to be worked out. Unlike other footnotes designed to protect existing services, it does not explicitly protect existing services from interference or indicate that FPLMTS systems will have to accept interference without recourse (a secondary status). This essentially creates a vague new category of operation (neither primary nor secondary) applicable only to FPLMTS.

Finally, the technical details of FPLMTS are just starting to evolve. Many observers expect that if and when a unified concept of FPLMTS does emerge, it will come slowly and initially be terrestrially-based. Any satellite component of FPLMTS cannot come into operation until 2010, and then will be subject to stringent coordination requirements that were laid out for new mobile satellite systems in Resolution 46.

The result is that the implementation of FPLMTS is essentially uncharted territory. Arrangements will have to be worked out as individual systems come into operation, or, more likely, further regulations and operating parameters may have to developed at a future world radiocommunication conference. For example, as noted in Resolution 211, the CCIR has determined that FPLMTS will not be able to share spectrum with the Space Services (see section below). Thus, the potential impact of FPLMTS on space communications will be very carefully watched by the world's space agencies. In addition, some of the frequencies identified for FPLMTS are also allocated to MSS. Sharing concerns could seriously constrain or limit the future development of FPLMTS.

*Marketing Uncertainties:* The future of FPLMTS is cloudy from a market perspective as well. While predictions about the potential of personal wireless communications systems are not in short supply, demand may be. There are already several different types of mobile systems operating and under development in Europe, including GSM, CT-2/Telepoint, and personal communication networks (PCN).[75] It remains to be seen if all these mobile services will be viable. In the United Kingdom, for example, Telepoint services-in which users carry portable phones that can only make calls, not receive them-failed to attract many subscribers and the industry is

---

[74] The band designated for DECT/PCS is 1.880-1900 MHz, which overlaps the WARC-92 designated FPLMTS bands. Each EC country has implemented the allocation as required. See Kurt Wimmer, "Global Development of Personal Communications Services, " *Communications Lawyer*, summer 1992.

[75] John Williamson, "U.K. PCN Rubber Hits the Road, " *Telephony,* vol. 222, No. 14, Apr. 6, 1992, p. 7.

[76] There is only one remaining Telepoint operator (Hutchinson) in the United Kingdom. It now has 9,000 base stations in operation and expects to build 3,000 more. Kurt Wimmer, personal communication% Nov. 20, 1992.

struggling to stay alive.[76] PCN trials have also been beset by difficulties, but at least two systems are expected to begin operations over the next year. However, the slow start of PCN in the United Kingdom does not seemed to have caused other countries to abandon PCN--Germany and France are both moving ahead with their PCN plans,

The total size of the market for mobile services may not support many competing technologies and systems. GSM operators, for example, often view PCN as a threat since it represents ''another purchasing option. ''[77] The wide variety of mobile systems-GSM, PCN, CT-2, microcellular, various satellite systems that are being planned-may cause consumer confusion similar to that being experienced in the evolution of technologies for playing prerecorded music. In that case, a number of competing formats (cassettes, Digital Audio Tape, Digital Compact Cassettes, Compact Discs, Sony's Minidisc, etc.) maybe causing consumers to resist merely buying the latest technology. A similar trend toward confusing and competing mobile telephone systems may cause consumers to resist buying until the market shakes out and one system becomes dominant. The battle between GSM and PCN in Europe could preview similar conflicts between cellular and PCS in the United States.

Domestic Issues—In the United States, the development of future terrestrial mobile services is similarly unclear. The cellular industry, which has been a world leader since its inception in 1983, and continues to add subscribers at a rapid pace, is now struggling to improve and expand its systems. In contrast to the GSM plans of Europe, there is no settled plan in this country to provide one unified cellular system, and technical and billing problems still exist when cellular users "roam' outside their home systems,[78] In addition, the cellular industry is in the middle of a heated battle over the choice of a standard for the industry that would cover the next generation digital cellular systems now being designed.[79] Such difficulties threaten to slow the development of future mobile services in this country, and have led some analysts to conclude that the United States now trails Europe in the deployment of advanced mobile technologies.

Like FPLMTS internationally, the FCC faces a similar problem defining the future of mobile communications for the United States. Is the American conception of PCS similar to the United Kingdom's PCN? Or is it more general? Does it compete with cellular or complement it? At different points in time, and depending on who was asked, the answer to any of these questions could be ''Yes, ' ''No,' or 'Maybe.' Recognizing the inherent uncertainty and danger in pigeonholing a new technology/service, the FCC has so far adopted the widest possible definition for PCS—it is all things to all people.

One of the more difficult questions facing U.S. regulators and policymakers is the relationship of U.S. PCS systems to FPLMTS. Should the United States support FPLMTS? If PCS is developed before FPLMTS begin operating, should FPLMTS be made compatible with PCS? How?

---

[77] GSM and PCNs are quite similar technically. GSM operates in the 900 MHz band, and PCNs (in Europe) "essentially are GSM at 1.8 GHz instead of 900 MHz. " John Williamson, ''GSM Bids for Global Recognition in a Crowded Cellular World," *Telephony,* vol. 222, No. 14, Apr. 6, 1992, p. 37.

[78] McCaw Cellular Communications, Inc. and southwestern Bell Corp. did announce plans to make cellular service available nationwide by negotiating with local franchises across the country to ensure common service standards that would allow seamless transitions between different service areas. GTE Corp., Bell Atlantic, NYNEX, and Ameritech have also announced a nationwide cellular plan that would challenge McCaw's system. Mary Lu Carnevale, ''GTE, Baby Bells Issue Challenge to Cellular One, " *Wall Street Journal,* Feb. 11, 1992, p. B 1.

[79] The battle is between Time Division Multiple Access (TDMA), which was ''officially'' chosen by the Cellular Telecommunications Industry Association (CTIA), and Code Division Multiple Access (CDMA), which, although Icss developed than TDMA, has caught the attention of some large cellular providers due to its promised larger capacity gains over TDMA. CTIA is now evaluating both technologies. For a discussion of the TDMA vs. CDMA debate, see Global *Telecom Report, ''TDMA* Has Been Selected as Standard, but CDMA Is Gaining Visibility and proponents, " vol. 8, No., 2, July 27, 1992.

Should the United States continue to oppose FPLMTS if it appears that it will not be compatible with PCS? What are the implications of the U.S. building a system (with all necessary standards and protocols) not supported by other nations of the world? As other countries outside of Europe adopt GSM as the standard for next-generation mobile communications, some analysts fear that the United States may become surrounded and outnumbered by GSM users. It may also be possible that-looking beyond GSM—FPLMTS will "encircle" PCS as well. The risks and advantages of such an outcome, and the policies leading to it, should be carefully weighed while policy can still be adapted to fit the international context.

The case of mobile communications points out a serious tension in American telecommunications policy. It must somehow balance the need for aggressive policy with a philosophical commitment to marketplace solutions. Aggressive policymaking that sets clear direction could provide focus to U.S. development efforts and allow U.S. companies to compete more effectively abroad. Many members of the private sector called for such leadership during WARC-92 preparations, a call that went largely unanswered. The disadvantage to this approach is that choosing the "wrong" policy direction may commit U.S. interests to a technology path that does not endure.

Unfortunately, unlike the Europeans, the United States has no coherent policy to guide the development of mobile services, nor even any general direction that could guide policymaking. The United States is committed to a policy that lets the market decide. So far, some would argue, the development of cellular technology has been remarkably successful-judging by increasing numbers of users and revenues. Such success, however, when judged in an evolving international context, may be short-lived. Many technologies, including PCS, MSS, cellular, and LEOS, are now fighting for spectrum (see figure 2-4) and customers, and time may be working against U.S. interests.

The United States can no longer afford to let the market decide-the potential for these new services is too important in terms of benefits to the American consumer, the revenues that could be generated, and the boost to American competitiveness that a focused approach to mobile communications could provide. U.S. spectrum managers and policymakers must make strategic decisions and hard choices to avoid the kinds of self-destructive technology battles that have held back other communications services-AM stereo, and now digital cellular standards. More aggressive oversight and guidance (leading to unified action) is needed if the United States is to effectively move forward in pursuit of world mobile communication markets. Otherwise, domestic battles may destroy America's ability to wage the war abroad.

## SATELLITE MOBILE SERVICES

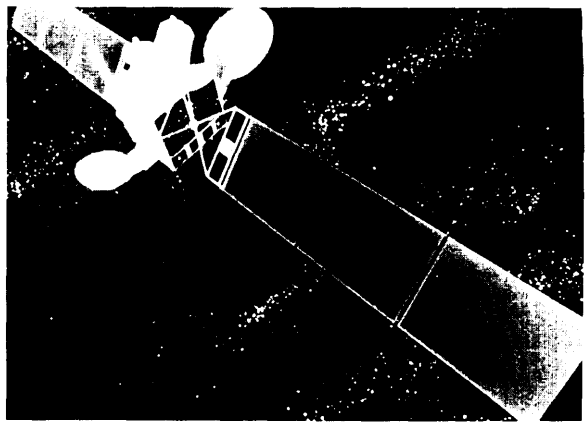
In addition to terrestrially-based mobile communication services, companies around the world have proposed to use satellites to deliver mobile services. For communications providers, satellite-based systems offer ubiquitous coverage of large (hundreds or thousands of miles across) areas, the remotest of which may be uneconomical for terrestrial systems to reach. Satellite-based communication systems have also become increasingly attractive to users because advances in technology have produced smaller, lighter, and less expensive user equipment and a wider range of applications, including telephony, remote data collection, data communication, position determination, etc. At WARC-92, ITU members considered allocations for three types of MS S-each offering overlapping services, but using different system configurations and user equipment. The following three sections discuss: geosynchronous MSS, LEOS systems planning to offer data services, and LEOS systems planning to offer telephone services.

## Mobile-Satellite Services[80]

### BACKGROUND

**Since the** mid-1980s, consumer demand for MSS has grown rapidly. Comsat's mobile services revenue, for example, rose from 14 percent of total revenues in 1988 to 20 percent in 1990.[81] Proponents of MSS see satellites as an economical and efficient way to deliver telecommunication services to users across wide areas. They point alternatively to the congestion of many cellular systems as evidence of the demand for such services and to the lack of nationwide mobile services as an advantage of satellite delivery. As a result, the demand for additional spectrum for MSS has grown dramatically both domestically and internationally.

The development of MSS in this country dates back to the early 1980s. In 1985, the FCC released a NPRM to allocate frequencies and develop regulatory and technical policies that would foster the development of MSS.[82] As a result of that 2-year proceeding, the FCC reached two important conclusions: 1) given the limited amount of spectrum then available, MSS services, including aeronautical, land, and maritime applications, could only be efficiently and economically provided by one licensee, and 2) the sole licensee should be a consortium of the applicants who had previously applied to provide MSS. As a result of this decision, the American Mobile Satellite Corporation (AMSC) was formed and granted the sole license in the United States to provide MSS



Intelsat

*Satellites in geosynchronous orbit 22,300 miles above Earth are being used to provide a variety of mobile communication services to aircraft, ships, and vehicles.*

*in the 1545-1559* MHz and 1646.5 -1660.5 MHz bands.[83] As currently conceived, AMSC's MSAT system will cover all of North America, and will offer a range of services, including nationwide mobile telephone service, paging, data communication, and position location services to land, maritime, and aeronautical users (trucking or shipping companies, for example). AMSC also plans to provide communications for civil aviation, including air traffic control and flight management communications to support safety services and airline passenger telephone calls. In 1992, AMSC began offering data messaging services using leased satellite capacity from Comsat. Customers using this service will even-

80 Although MSS technically refers to all types of mobile satellite systems, including LEOS, in this section MSS will refer only to geosynchronous satellite systems. LEOS systems are discussed separately below.

81 Andrew Lawler, ' 'Political, Economic Changes Draw New Markets, " *Space* News, vol. 3, No. 3, Jan. 27-Feb. 2, 1992.

82 For a discussion of the history of domestic and international MSS issues, see John Davidson Thomas, ' 'International Aspects 'f the Mobile Satellite Services," *Federal Communications Law Journal,* vol. 43, December **1990.**

83 Currently, the major stockholders of AMSC are Hughes Communications, Inc., McCaw Cellular Communications, Inc., and Mobile Telecommunications Technologies Corp., which together control approximately 90 percent of AMSC shares. The FCC's actions in this proceeding, including the validity of the consortium approach, have been challenged repeatedly on legal grounds. Although the court did reverse and remand the order establishing AMSC, the FCC subsequently reasserted the legitimacy of the consortium approach and the awarding of the sole MSS license to AMSC. Members of the aeronautical community appealed these decisions, but the case was dismissed on procedural grounds. The court, however, did note its concern over the FCC's authority to mandate licensee consortiums. "FCC, AMSC Get Victory by Default. . .," *Telecommunications Reports,* vol. 59, No. 5, Feb. 1, 1993.

### Box 2-B—Glossary of Satellite Terms

Throughout this report, many different terms are used to refer to different components of satellite communications systems. In many cases, the same thing will have many different names, each of which can be used more or less interchangeably. While some of these terms may have specific legal/regulatory or technical/engineering meanings, they are often mixed in colloquial speech. The following brief descriptions identify some of the terms that are used.

**Antenna:** An antenna is a part of the transmitter/receiver system that is used for radiocommunications. Antennas come in a variety of shapes and sizes. The term can refer to the simple 8-inch cellular antenna mounted on many cars or it can be used to refer to the TV antennas many people have on their houses. It is even used to refer to the larger more complex antennas used to communicate with satellites. A satellite dish, for example, is one form of satellite antenna.

**Dish:** A satellite transmitter/receiver. Since many satellite antennas are shaped like a large dish, they are often referred to as dishes. *See also* transmitters and receivers.

**Downlink:** Refers to the direction a radio signal travels as it moves from the satellite to the ground. In many International Telecommunication Union (ITU) documents, downlink frequencies will be identified as space-to-Earth or S-E. In figures and tables downlink frequencies are often distinguished by an arrow pointing down. Downlink is also often used as shorthand for an Earth station that receives signals from a satellite. *See also* uplink.

**Space stations:** Another term, sometimes used in the ITU vocabulary, for a satellite (not to be confused with manned space stations).

**Transmitters and receivers:** There are many names for the devices that communicate with satellites: station, receiver, terminal, and unit. Usually these terms refer to the antenna and the related electronics of the system. Often they are modified according to the specific function of the device: ground station, Earth station, and fixed station usually refer to larger satellite dishes mounted in one stationary location. User terminal or unit refers to any radio device used by an individual. There are two types of user terminals—portable (handheld) or mobile (mounted in a vehicle) communications. These devices are also sometime known as mobile Earth stations.

**Uplink:** Refers to the direction a radio signal travels as it moves from the ground (or an airplane) to a satellite. ITU documents frequently identify these frequencies as Earth-to-space, or E-S. In figures and tables, uplink frequencies are often distinguished by an arrow pointing up. Downlink is also often used as shorthand for an Earth station that sends signals to a satellite. *See also* downlink.

SOURCE: Office of Technology Assessment, 1993.

tually be switched over to AMSC'S satellite, which is expected to launch in late 1994.

The major global player in MSS is the Internationa1 Maritime Satellite Organization (Inmarsat). Inmarsat is an international cooperative owned by more than 60 countries, including the United States, who hold investment shares in the organization. Comsat is the official U.S. signatory to Inmarsat and the only authorized seller of Inmarsat services.[84] Although it was originally established in 1979 to serve the communication needs of ships-at-sea, Inmarsat has gradually

84 Inmarsat itself is not permitted to provide land or aeronautical mobile services in the United States, It does offer some maritime services.

expanded the scope of its activities to include international aeronautical communication services (begun in 1989), and land mobile communication services. Today, land mobile users make up 25 percent of Inmarsat's customers.[85]

### U.S. PROPOSALS

Winning support for MSS proposals was among the highest U.S. priorities at WARC-92. Under the umbrella of MSS, the United States had a number of interests to protect and promote, and these gave rise to several different proposals. The priorities (listed in no particular order) for the United States in MSS were to:

1. Convert the specific mobile satellite services (aeronautical, land, and maritime) into "generic" MSS, while providing adequate protection and priority for aeronautical and maritime safety communications;
2. Obtain new spectrum for MSS; and
3. Prevent reallocation of the 1435-1525 MHz band now used for aeronautical telemetry to MSS or BSS-Sound (see section on BSS-Sound for discussion).

Generic MSS—In the past, the ITU had subdivided the various mobile satellite services into three separate categories-aeronautical, land, and maritime-each with its own allocations. The United States first proposed that these separate allocations be merged into a single "generic" allocation at the 1987 WARC on mobile services (MOB-87), That proposal was not accepted by MOB-87, and the issue was carried over to WARC-92.

The WARC-92 U.S. proposal for generic MSS was premised on the belief that ''the current service specific allocations in the 1.5/1.6 GHz bands are too restrictive to permit flexible usage to adapt to dynamic changes in communication needs. We recognize, however, that special provisions are necessary so that safety services will be protected from interference, and that these services will be ensured priority access over other communications in these bands. ' '[86] The current division of MSS, U.S. spectrum managers believe, leads to inefficient use of the spectrum because radio frequencies cannot be transferred quickly enough for use by the most-demanded services-leaving some services with too much spectrum, while others face spectrum shortages and congestion. In order to eliminate this form of structural inefficiency, the United States proposed to merge the specific MSS (aeronautical, land, and maritime) into generic MSS, while providing special protections and preemptive access to the safety services. Government spectrum managers believe that such safeguards would be adequate to protect safety needs of the aeronautical and maritime communities.

U.S. proposals targeted a total of 61 MHz for conversion to generic MSS. The United States proposed to reallocate the Land Mobile-Satellite (LMSS) and Maritime Mobile-Satellite Service (MMSS) bands at 1530-1544 MHz (downlink) and at 1626.5 -1645.5 MHz (uplink) to MSS.[87] And in the bands 1545 -1559 MHz (downlink) and 1646.5 -1660.5 MHz (uplink), the United States proposed to reallocate the Aeronautical Mobile-Satellite (Route) Service (AMS(R)S) and LMSS to MSS.[88]

Additional MSS allocations--In addition to these changes, the United States sought additional allocations for MSS. As noted above, the United States proposed to make 19 MHz of spectrum at

---

85 Ellen Messmer, ''Inmarsat Ready to Challenge Iridium,'' *Network World, Mar. 16, 1992.*

86 U.S. proposals, op. cit., footnote 5, p.4.

87 In order t. balance amount of spectrum available for uplinks and downlinks, the United States also proposed to allocate the band 1525-1530 MHz to the mobile-satellite service (space-to-Earth). See below. This proposal includes priority access for maritime safety communications as indicated in the proposed footnotes that accompany the frequency proposal.

88 This proposal provides priority access with real-time preemptive capability for the Aeronautical Mobile-Satellite (Route) Service. This access was proposed in a footnote accompanying the allocation proposal.

1626.5 -1645.5 MHz (uplinks) generic. The companion (paired) generic MSS downlink band for these frequencies at 1530-1544 totaled only 14 MHz.[89] Consequently, the United States proposed to add 5 MHz (1525-1530 MHz) to the newly generic MSS downlink band at 1530-1544 MHz, thus balancing the amount of spectrum available for both uplinks and downlinks.

The United States also proposed new worldwide allocations of 80 MHz (40 MHz each for uplinks and downlinks) for MSS. The proposed allocations were 2110-2130 MHz and 2160-2180 MHz (downlinks), and 2390-2430 MHz (uplinks). For ITU Regions 1 and 3, the United States also proposed to allocate (through footnotes) the bands 2500-2535 MHz (downlink) and 2655-2690 MHz (uplink) to MSS. Finally, the United States proposed an allocation footnote to add MSS to the 1850-1990 MHz band. This addition was intended to provide future spectrum for MSS operations, including LEOS systems.[90]

## RESULTS

United States MSS proposals enjoyed mixed results at WARC-92. The U.S. proposal to convert existing aeronautical, maritime, and land mobile satellite service allocations into a generic MSS allocation worldwide was generally not successful—WARC-92 let stand the existing divisions between the specific services (see figure 2-5). This outcome was not surprising given past opposition. International support for maintaining a separate band of frequencies for satellite services serving airline routes was especially strong.

The United States achieved part of its goal, however, by inserting two footnotes in the crucial bands indicating that MSS would be allocated on a primary basis in this country and several others.[91] Footnote 726C allocates 1530-1544 MHz and 1626.5 -1645.5 MHz on a primary basis, but only in Argentina, Australia, Brazil, Canada, Malaysia, Mexico, and the United States, and maritime distress and safety services have priority. The effect of this footnote is to make MSS primary in all of North America. Footnote 730C allocates the 1555-1559 MHz and 1656.5 -1660.5 MHz bands to MSS, but only in the United States and Argentina, and provides priority access to AMS(R)S.

Regarding new MSS allocations, some of the U.S. proposals were accepted, some were not. New spectrum was allocated to MSS in a number of bands (see box 2-C and figure 2-4), but the new allocations are modified, and in some cases severely constrained, by a complex array of footnotes that specify power levels, coordination requirements, and implementation dates. Because of these limitations, the United States entered two reservations in the Final Acts of WARC-92 complaining g about the "unduly restricted allocations" for MSS and the delay in making some of the new allocations available. Through these reservations the United States maintains its rights to use the bands as it deems necessary in order to meet the needs of mobile satellite systems in this country.[92]

## DISCUSSION

Domestic Issues-U.S. proposals were driven by the increased demand for mobile services in this country (and the perceived latent demand worldwide), the large geographic areas involved,

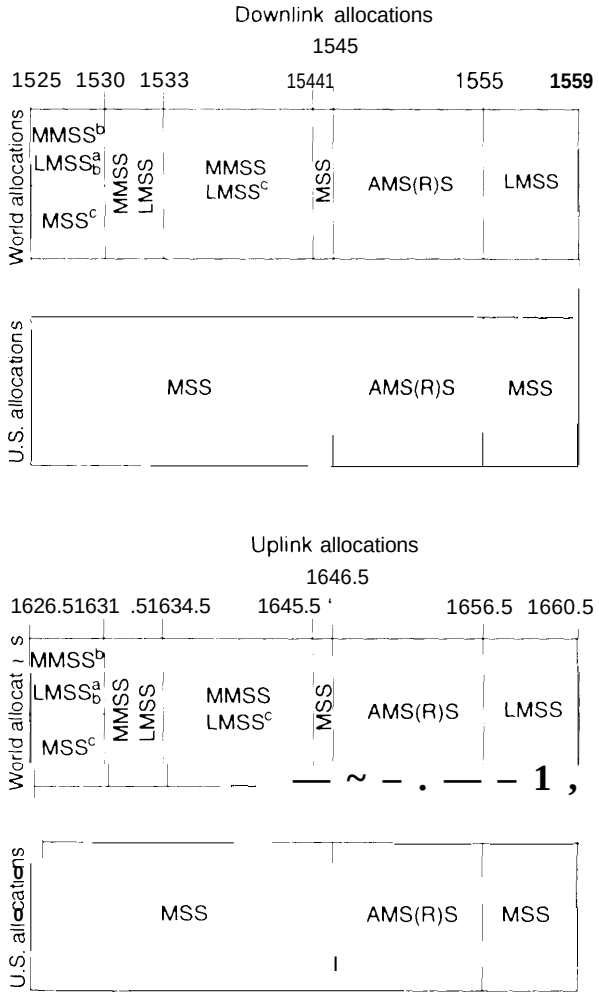
89 Satellite services are often allocated in paired bands. This means that all communications signals going to the satellite in one band will be transmitted back to Earth in the companion band.

90 The United States also wanted t. use these bands for future personal communications services development and wanted to reserve the band for possible satellite augmentation of terrestrial PCS systems.

91 Footnote 726C allocates the bands 1530-1544 MHz (downlink) and 1626.5 .1645.5 MHz (uplink) to MSS on a primary basis in Argentina, Australia, Brazil, Canada, the United States, Malaysia, and Mexico. Footnote 730C allocates the bands 1555-1559 MHz and 1656.5- 1660.5 MHz to MSS, but only in the United States and Argentina. Provisions are made to protect and provide emergency access for maritime (and other) safety communications.

92 International Telecommunication Union, WARC-92, Document 389-E, Mm. 3, 1992, P. 29.

Figure 2-5—WARC-92 L-Band Mobile-Satellite Service Allocations




[a] Secondary
[b] In Region 1 only
c In Regions 2 & 3 only

KEY: AMS(R)S=Aeronautical Mobile-satellite (Route)Service, LMSS=Land Mobile-Satellite Service, MMSS-Maritime Mobile-Satellite Service, MSS=Mobile-Satellite Service.

SOURCE: Office of Technoloyg Assessment, 1993.

and the rapid development of satellite technologies. AMSC's stated need for more spectrum--so that it could compete with other international satellite systems—was an important consideration.[93] In addition, the desire to foster the development of this newly emerging, and poten-

93 The Limited amount of spectrum allocated to MSS worldwide prior to WARC-92, combined with the number of counties/companies planning to launch MSS systems made sharing the spectrum essential. As a result of preliminary negotiations with some other countries, AM and the Federal Government believed that there simply was not sufficient spectrum to support all the competing systems, including AMSC. Without adequate spectrum, AMSC would have had serious difficulties offering the number and quality of services it had planned.

### Box 2-C—WARC-92 Allocations for the Mobile-Satellite Service

WARC-92 allocated frequencies for MSS in a number of bands (see figure 2-4 for an overview of these new allocations):

*1525-1530 MHz* (downlink)—These frequencies were reallocated to MSS in order to supplement the downlink band at 1530-1559 MHz and match the amount of spectrum (34 MHz) previously allocated to MSS uplinks at 1626.5-1660.5 MHz. The allocation in Regions 2 and 3 is to MSS on a coprimary basis. In Region 1, however, the allocation is limited to Maritime MSS coprimary and Land MSS on a secondary basis. Use of these bands (1525-1559 MHz and 1626.5-1660.5 MHz) is subject to coordination and notification procedures set out in Resolution 46.[1]

*1530-1559 MHz* (downlink)—the United States proposed to make the frequencies in this band part of a generic MSS allocation, reallocating the individual (land, maritime, aeronautical) mobile satellite services to general MSS. These proposals were not accepted by the conference. However, the United States (joined importantly by Canada and Mexico) did succeed in inserting a footnote (726C) in the allocations table that makes MSS an additional primary allocation in 1530-1544 MHz (downlink) and 1626.5-1645.5 MHz (uplink), with account taken of distress and safety services. The United States (joined by Argentina) also inserted footnote 730C, which makes MSS coprimary in the 1555- 1559 MHz band, but gives priority to aeronautical safety communications (AMS(R)S).

*1626.5-1660.5 MHz* (uplink)—The United States also proposed to make these frequencies part of a global generic MSS allocation, a proposal that was again rejected by the world community. Use of these bands remains allocated to the individual MSS services (with MSS at 1626.5-1631.5—see figure 2-5). The United States inserted a footnote (726C) allocating 1626.5-1645.5 MHz to MSS, but giving priority access to maritime distress and safety systems. Footnote 726X makes these frequencies subject to the provisions of Resolution 46. In addition, the band 1645.5-1646.5 MHz is limited to distress and safety communications (footnote 734B). Footnote 730C makes MSS

[1] The United States, joined by the United Kingdom, entered a reservation in the Final Acts of WARC-92 stating that they "will not accept any commitments for this form of coordination arising from omission of the term "non-geostationary" in the text of certain footnotes [726X]. . ." International Telecommunication Union, WARC-92, Document 395-E, Mar. 3, 1992, p. 4. Thus, the United States may not abide by the decision of the conference with regard to coordination of these bands when geostationary satellite systems such as AMSC's are involved.

tially important and profitable industry, and to keep America at the forefront of satellite technology and services, quickly made MSS proposals one of the most important priorities for the **United** States and a major focus of U.S. WARC-92 preparations and negotiations.

Although many in the Federal Government, including NTIA, support the concept of generic **MSS allocations, U.S.** proposals for converting the individual mobile satellite services (aeronautical, maritime, and land) into a generic allocation for MSS were generally opposed by the individual user communities, both domestically in the U.S. preparation process and at the WARC itself (see below).

International and WARC-92 Issues-The United States has been fighting the battle of generic MSS since the mid-1980s. Inmarsat **has** opposed the idea, and the international aeronautical community, which wants to maintain a separate band for aeronautical safety communications or at least ensure that safety communications are protected from interference and continue to have priority access to satellite communication channels in the event of an emergency, has been especially critical of the generic concept. They believe that the rise of commercial MSS will eventually reduce the amount of spectrum available for aeronautical safety communications and subject such communications to increasing inter-

a primary allocation in 1656.5-1660.5 MHz in the United States and Argentina, with priority access given to aeronautical safety services (AMS(R)S).

***1492-1525 MHz*** (downlink)—The United States did not propose these frequencies for MSS, but (only in Region 2) they were allocated. The United States, in order to protect its existing use of the band for flight testing of aircraft and weapons systems, inserted footnote 722B to maintain the U.S. use of the frequencies only for fixed and mobile applications. In addition, WARC-92 paired this allocation with frequencies allocated at *1675-1710 MHz* (uplink- Region 2 only) to MSS on a coprimary basis (shared primarily with meteorological services). The latter frequencies can be used in the United States.

***1930-1970 MHz*** (uplink)—This band was allocated to MSS (in Region 2 only) on a secondary basis, but this allocation is also part of the band of frequencies that is intended for use by FPLMTS. That intention, however, does not preclude the use of the band by other allocated services.[2] This band is paired with frequencies in the *2120-2160 MHz* band (for the downlink, again in Region 2 only), also on a secondary basis, which is also identified for use by FPLMTS.

***1980-2010 MHz*** (uplink)—This band was allocated on a worldwide basis to MSS coprimary with mobile and fixed services, but in Region 2, an additional allocation was made to MSS at 1970-1980 MHz, bringing the total allocation to 40 MHz in Region 2. These allocations are also part of the band of frequencies that is intended for use by FPLMTS. That intention, however, does not preclude the use of the band by other allocated services.[3] WARC-92 paired this band with downlink frequencies in the *2170-2200 MHz* band. Additional allocations were made at 1970-1980 MHz (uplink) and 2160-2170 MHz (downlink), but only for Region 2.

Footnote 746X states that use of these bands for MSS shall not begin before January 1, 2005, and that such use is subject to the provisions of Resolution 46. In another footnote the United States pushed up the earliest date for implementation in this country to January 1, 1996.

***2500-2520 MHz*** (downlink)—This band was allocated on a primary worldwide basis, to be paired with *2670-2690 MHz*. Use of this band cannot begin before 2005 and is subject to the provisions of Resolution 46.

[2] See footnote 746A.

[3] See footnote 746A.

SOURCE: Office of Technology Assessment, 1993.

ference. While U.S. spectrum managers maintain that adequate safeguards can be built into technology and accomplished through rule changes, representatives of the aeronautical community in both the United States and in international aviation organizations, such as the International Civil Aviation Organization (ICAO), are skeptical that such protection can be provided through either technical or procedural means. They are concerned that air safety (and existing investments in equipment) will be compromised if civil aviation users are forced to share spectrum with commercial MSS providers .94 The maritime community is similarly concerned that future development of MSS services in the bands could degrade the future worldwide Global Maritime Distress and Safety System (GMDSS). To date, the arguments against generic MSS have been more persuasive internationally.

94 Domestically, the battle between AMSC and the aeronautical community continues. ARINC, Inc., and other groups have filed suits challenging AMSC'S license, and they continue to doubt the ability of AMSC to ensure the reliability and preemptive access of aeronautical satellite communications required by the FCC and international rules. The FCC recently declined to adopt standards for such operations, leaving it instead to AMSC to design the system itself. *Telecommunications Reports, "FCC* Adopts Technical Standards, Licensing Requirements for Aircraft Earth Stations, " vol. 58, No. 37, Sept. 14, 1992.

The negotiations over additional allocations for MSS were some of the most contentious of WARC-92. The greatest difficulty in negotiating new MSS allocations was in overcoming the resistance of other countries who were trying to protect their existing services. Many countries believe that (U. S.) satellite systems will cause interference to the existing services in the bands—just as the maritime and aeronautical communities believe that such systems will cause interference to their systems.

This difficulty was compounded by the opposition of the European bloc to any new U.S. MSS allocations. Even before WARC-92 began, battle lines had been drawn between the United States, for whom MSS was a high priority, and Europe/CEPT, which generally opposed U.S. MSS allocation proposals. At the conference, both sides refused to compromise, and despite some promising rumors, negotiations remained deadlocked for 3 weeks. Only 3 days before the end of WARC-92, no agreement had been reached, and the heads of delegations for the principal countries involved tried to negotiate a solution. Finally, in the last hours of the conference (between 2 AM and 7 AM), a deal was struck in which European opposition to MSS was dropped in return for U.S. concessions on FPLMTS.

### ISSUES AND IMPLICATIONS

Allocation Issues-WARC-92 outcomes represent a step forward for the U.S. MSS industry, but successes were limited, and several issues will likely be revisited. Most significantly, some new spectrum was allocated for MSS use. However, while the additional spectrum allocated to MSS is important, the proponents of these new systems, both in the United States and abroad, believe that the frequencies allocated to MSS are still inadequate. Around the world, a number of countries are developing MSS systems (both regional and global in scope), each with its own spectrum needs. These needs, however, greatly exceed the amount of spectrum currently allocated to MSS. In addition, some of the new bands allocated to MSS by WARC-92 cannot be used before 2005-too late to accommodate all the systems now being developed.[95] The limited amount of additional spectrum that was allocated to MSS at WARC-92 and the limitations placed on the new allocations mean that this issue will almost certainly be revisited at a future world radiocommunication conference. MSS proponents believe that restrictions could be reduced as the systems come into operation, and more spectrum may be allocated as demand for the service increases.

As a result of the difficulty in coming to agreement on MSS issues, many footnotes were inserted into the allocations covering MSS. These footnotes modify the allocations in many ways—setting specific dates, varying the allocations in different countries, specifying coordination requirements, etc.—all of which serve to protect existing services, but which also constrain the introduction and/or operation of mobile satellite systems and services. Moreover, because of the technical detail in the MSS footnotes and the sometimes vague way in which they were written, these footnotes are subject to continuing interpretation.

Serious economic concerns underlie the MSS footnotes-concerns that are not amenable to technical frees and that will only be solved through intense negotiation. Years will be needed to develop, interpret, and negotiate the practical meaning of some of them. To what extent this will slow the development of mobile satellite services is uncertain. The U.S. Government and AMSC have already begun the process of coordinating U.S. MSS services worldwide.

The general failure of the U.S. generic proposals could constrain the development of future global MSS systems in the L-band. The **fact that MSS exists in a generic sense only in North**

95 This date is noted in footnote 746X. The United States, feeling this date was too far in the future, succeeded in inserting another footnote in the table of allocations (746U) that moves up the date at which MSS services can begin in the United States to Jan. 1, 1996.

America (in 1525-1544 MHz and 1626.5 -1645.5 MHz—footnote 726C) or only in the United States (in 1555-1559 MHz and 1656.5 -1660.5 MHz—footnote 730C) means that any global MSS system the United States might put into orbit must conform to the international allocations when operating in other countries. It remains to be seen how serious this restriction will be. AMSC, for example, plans to serve only North America, and is constructing its system accordingly-it will not be affected directly by the regional allocations in Regions 1 and 3. The United States will undoubtedly press for generic allocations in these bands at future conferences in order to allow more flexible uses of these frequencies by a variety of satellite services. This position will likely continue to be opposed by the aeronautical and maritime communities until such time as the technical viability of providing them priority access to MSS frequencies can be proven.

Competition with Terrestrial Services—The impacts of MSS services on terrestrial mobile services is unclear. Both of these delivery systems will provide essentially the same services—telephone, paging, and data communications. The most important question facing mobile service proponents is: is the overall market for mobile communication services large enough to support many different technologies and companies? The market will ultimately decide if MSS becomes a mass market consumer service or a service targeted to niches such as trucking companies, fleet management services, and/or national paging services.

Some analysts have commented on the ability of future satellite services to provide competition to cellular telephone operators—and the beneficial effects this competition would have on prices and service. While such competition could have beneficial effects, it is not yet clear if MSS systems will compete directly against cellular systems or if MSS could provide effective competition to the cellular providers in more than a few markets or niche applications. The strategy of some MSS providers (including big LEOS), at least publicly, is to provide services that "complement" the existing cellular systems by targeting areas not served by cellular systems and/or individuals who frequently roam between different cellular systems. If these services prove successful, however, it is likely that the satellite companies will begin to compete with the cellular telephone companies for the same customers.

Future of the U.S. MSS Industry---Given the additional spectrum allocated to MSS at WARC-92 and the likelihood that additional spectrum for MSS will be made available at future WARCs, the domestic structure of the U.S. MSS industry and the policies governing it should be immediately reviewed. The questions involved in determining the future of MSS in this country are complex and will require high-level policy decisions that take account of many important technical, economic, and political factors. This issue graphically demonstrates the importance of having a framework in place through which to develop consistent and aggressive policies that would support the development of mobile (including terrestrial and satellite) services in this country.

Several domestic MSS issues remain unresolved. Fundamentally, the decision facing the FCC and the Congress is how much competition to allow in the MSS industry. AMSC has been licensed for several years as the sole provider of MSS (in the bands 1545—1559 MHz and 1646.5-1660.5 MHz) in the United States, but its role and very existence continue to be challenged in court.[96] Furthermore, the additional spectrum allocated to MSS at WARC-92 calls into question the

[96] AMSC, and the rationale for establishing a consortium approach for MSS, has been challenged in court and survived SO far. If the FCC and AMSC lose, the U.S. MSS industry (which essentially is AMSC) could be seriously set back. AMSC has been the focal point of U.S. coordination discussions internationally, and satellites arc already being constructed. If AMSC is invalidated, or if MSS services are opened for (additional) applications, deployment of MSS in this country could be delayed.

FCC's original rationale for granting only one MSS license-namely that there was only enough spectrum to support one licensee.

Since its creation, the FCC has carefully protected and supported AMSC. Some observers hypothesize that since the FCC created AMSC, it feels responsible to defend it against all threats—domestic and foreign. However, although the FCC's desire to protect AMSC and promote the development of a costly and risky new service is a laudable goal, the conditions that led to that decision have changed and will continue to evolve. The rapid development of alternative MSS technologies (LEOS), for example, and the FCC's support of them undermines AMSC's and the FCC's arguments that AMSC must be initially protected from competition in order to survive. LEOS systems will provide similar services and presumably compete head-to-head with AMSC in many markets and service segments.

Such developments call into question the belief that the protection of AMSC as a regulated monopoly is in the best interests of the citizens of the United States. On one hand, government and AMSC officials believe that the regulation and protection of AMSC are necessary to ensure that the system/company can survive and begin offering services. If AMSC was not protected and ultimately failed, there would be no mobile satellite service in this country, and the United States would suffer a serious setback in the international negotiations now going on to work out spectrum sharing arrangements among the proposed MSS systems. In addition, if AMSC were to fail, and no company or system could quickly take its place, Inmarsat could step in to provide services--on a monopoly basis with monopoly prices.

On the other hand, entry of Inmarsat into U.S. markets could be beneficial to American consumers if a "level playing field" for competition could be created and maintained. As noted above, Inmarsat has been aggressively expanding its role and customer base for the last several years, and has targeted land mobile telecommunications as an **area** for future growth. International paging using Inmarsat satellites is expected to begin in 1994, and the organization has announced plans to provide telephone and other services in competition with the U.S. LEOS providers (see below). When the FCC allocates additional spectrum to MSS in conformance with WARC-92 decisions, Inmarsat could potentially provide services in competition with AMSC—if it were allowed into U.S. markets. However, if a worldwide system such as Inmarsat was permitted to operate in the United States, it would reduce the amount of spectrum available for U.S. domestic systems—perhaps making their services difficult or impossible to deliver.

A true commitment to competition and its presumed benefits-lower prices and better quality-require that the possibility of opening the U.S. market to other MSS providers—both domestic and foreign—be examined. If AMSC is to continue to operate under protected monopoly status, the reasons for such an important policy decision must be carefully and openly examined in the light of evolving domestic and international considerations. It may be possible, given the availability of new spectrum, to open up MSS in the United States to even greater competition. With the procompetitive atmosphere that now exists at the FCC, in Congress, and in the executive branch, such a monopoly approach seems out of place. This debate points out the intricate and complex interconnections between (developing goals for) radiocommunication policy, WARCS, and trade policy.

## Little LEOS

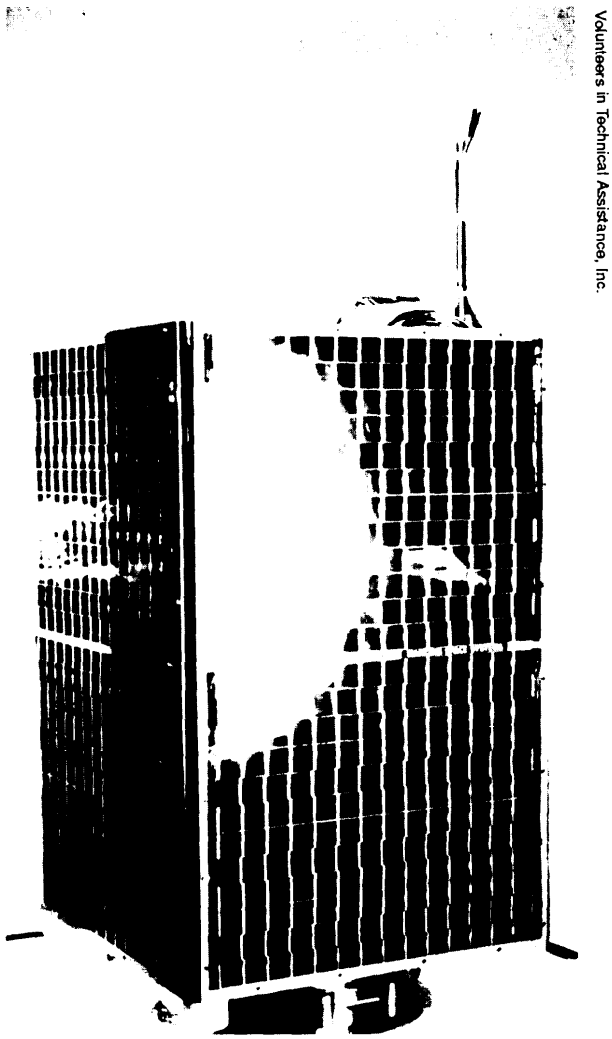
### BACKGROUND

**One of the greatest booms in the use of wireless** technologies has come in the demand for data communication and simple messaging applications. The growth in paging services and the more recent explosive growth in portable data communications-for service technicians in the field, for example-indicates a large, and as yet, unex-

ploited market for wireless data communication services.[97] In order to meet this perceived demand, several U.S. companies have proposed to use networks of low-Earth orbiting satellites to deliver two-way data, messaging, and position determination services worldwide. Because these systems will operate in frequencies below 1 GHz (in the VHF/UHF bands), and because they will use very small satellites, they are often referred to as "little LEOS," in order to distinguish them from similar networks of LEOS that plan to operate in frequencies above 1 GHz and deliver voice services as well as data (see section on ''big LEOS" below).

Current designs for the little LEOS systems envision networks of up to 24 satellites flying in orbits only several hundred miles above the Earth.[98] Depending on complexity, these satellites are expected to cost from $6 to $10 million each. On the ground, satellite dishes called network gateways located throughout the world will relay messages and data to the satellites that will then retransmit the information down to individual users who will receive it on small handheld terminals (see figure 2-6). Users will be able to send short messages back through the satellites to the gateways for delivery to other mobile users or through the public telephone network to family and friends or their company. Trucking companies, for example, could use the systems to locate cargoes or trucks, and to communicate with employees.

Little LEOS systems plan to offer a variety of communications services. The most basic service initially might be domestic one-way paging. The most advanced applications will allow users to send and receive messages on small, portable hand-held units that resemble large calculators with an antenna attached. These handsets will be able to receive and transmit messages of up to 200 characters, determine the users' location to within



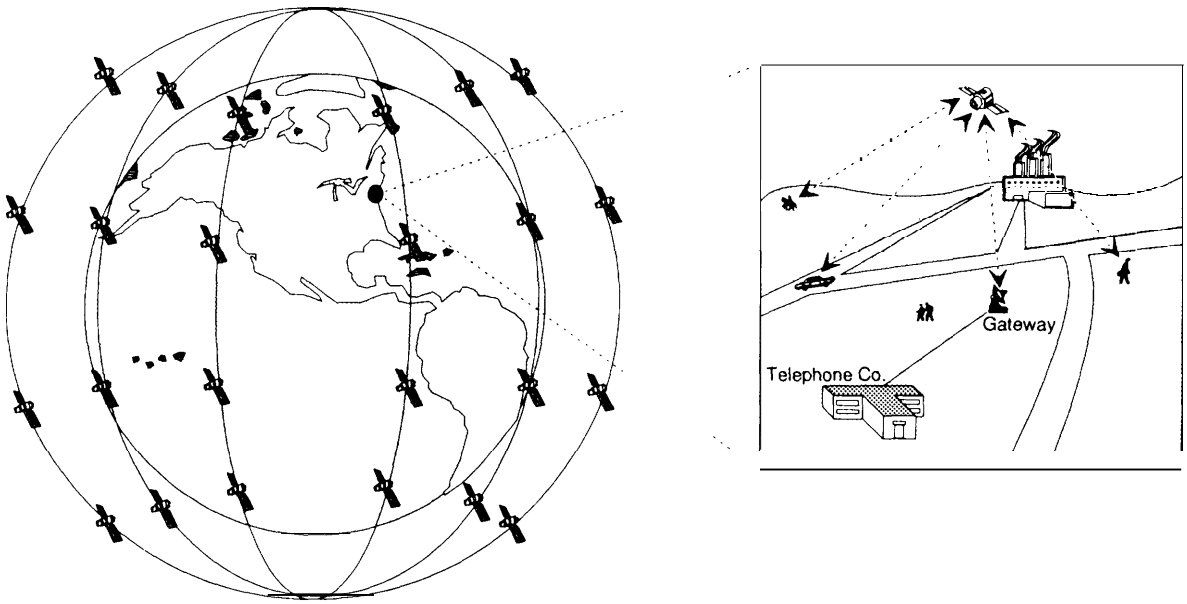
Volunteers in Technical Assistance, Inc.

*Small satellites such as this one, which is less than 4 feet tall, will bring data communications services to people around the world.*

97 See, for example, U.S. Department of Commerce, National Telecommunications and reformation Administration, *Telecom 2000: Charting the Cour.refer a New Century,* NTIA *Special* Publication **88-21** (Washington, **DC: U.S. Government Printing Office, October 1988).** A number of radio-based data communication networks are already operating in this country, including ARDIS (Motorola/IBM) and Ram Mobile Data (Ram/BellSouth), and the FCC has proposed allocating 20 MHz of spectrum for wireless data communication as part of its proceeding on PCS, op cit., footnote 63. Severat companies bave also announced plans to market data services that would use existing cellular telephone systems.

98 Geosynchronous-orbiting satellites, by contrast, are located 22,300 miles above the Earth.

**Figure 2-6-Generic Little LEOS System**




**SOURCE: Office of Technology Assessment, 1993.**

100 meters or less, and are expected to be relatively inexpensive (depending on features, current estimates range from $50 to $400). User terminals could also be installed in cars, trucks, and boats or even be integrated with a vehicle's radio system. An advantage offered by the little LEOS systems over terrestrially-based data services is their ability to supply location information to users and for other service providers. Lost hikers or boaters and stranded motorists, for example, could use the systems to send distress signals giving their exact location. Police could use such systems to find stolen cars. Finally, such systems can provide environmental or industrial monitoring by allowing stationary units to transmit weather or leak detection data to a central location.[99] The kinds of features a user wants will determine the type and cost of equipment needed.

### U.S. PROPOSALS

As a result of discussion in the FCC's Industry Advisory Committee and between industry and government interests, the United States proposed allocations for MSS to be used by little LEOS systems in three bands. The bands proposed were: 137-138 MHz (downlink), 148-149.9 MHz (Uplirlk), and 400.15-401 MHz (downlink).

### RESULTS

By most accounts, the United States did well with its little LEOS proposals. The frequencies the United States wanted were allocated, but some only on a secondary basis. Additional frequencies the United States did not propose were adopted for LEOS use, and interim coordination procedures for little LEOS operations were agreed to.

---

99 Such uses could also be two-way: the sensors could be polled for an immediate reading. Alan Pittman, "FCC Starts Pager Race," *Washington Technology,* vol. 7, No. 1, Apr. 9, 1992, p. 30.

WARC-92 allocated 137-138 MHz for little LEOS downlinks. However, in order to protect existing services, the band was broken up into subbands, some of which are primary while others are secondary (see figure 2-7). This spectrum will be shared on a coprimary basis with space operations and research services and meteorological satellite operations, and with fixed and mobile services (both secondary).

The 400.15-401 MHz band was also allocated for LEOS downlinks. This band will be shared with the meteorological aids and satellite services and space research services on a coprimary basis and space operations on a secondary basis. LEOS services may operate freely in these two bands as long as they stay below a certain level of power (so as not to interfere with existing services). However, if the signal from the satellite exceeds that "trigger" level (it is too powerful when it reaches the ground), the little LEOS service provider must coordinate the system with existing users (see discussion of Resolution 46 below).

The band 148-149.9 MHz was allocated for LEOS uplinks on a coprimary basis with fixed and mobile services. However, in order to protect existing services, WARC-92 put limitations on LEO operations in this band that are stricter than for the downlinks. First, conference delegates agreed that ''the mobile-satellite service [including LEOS services] shall not constrain the development and use of fixed, mobile and space operation services in the band 148- 149.9 MHz."[100] Second, the power levels of the mobile user terminals cannot exceed a specified level (in countries which have not allowed the service), which is very low—lower than limits on the other bands. And unlike the power levels specified in the 137-138 and 400.15-401 MHz bands, the limits in this band are absolute. If a country has not permitted the system to operate within its borders, the power 1evels in the offended country may not exceed these limits under any circumstance.



Orbital Communications Corp.

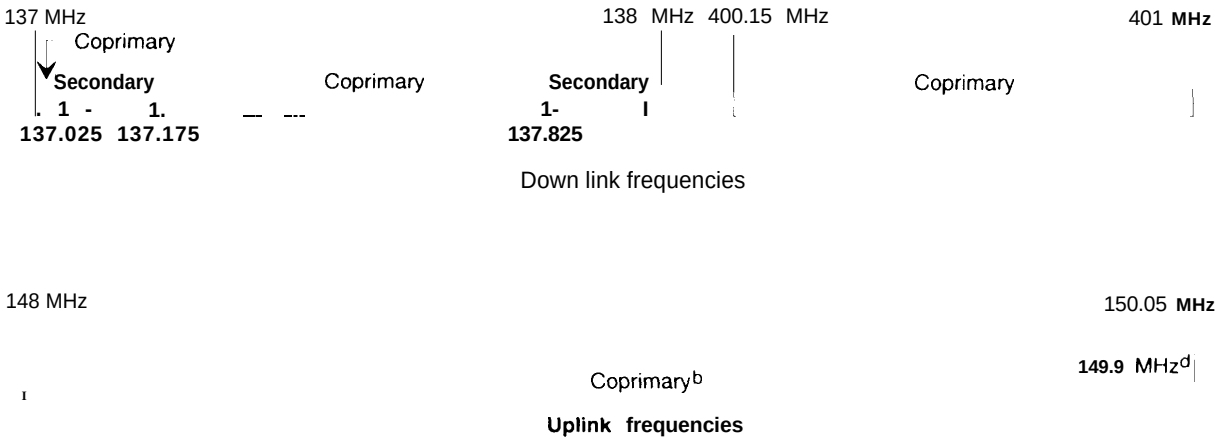
*Hand-held terminals will enable consumers and business users to send and receive short messages around the world and determine their location anywhere on Earth to within 100 meters.*

More importantly, many countries (including most of Europe, many African nations, Canada, Russia, and others, but *not* including the United States) have effectively made these LEO uplink frequencies secondary (see box 2-A for a discussion of the differences between primary and secondary status for radio services) in their countries by inserting a footnote into the international Table of Allocations stating that:

> [s]tations of the mobile-satellite service in the band 148-149.9 MHz shall not cause harmful interference to, or claim protection from stations

100 ITU, *Addendum and Corrigendum,* op. cit., footnote 61, p. 1.

**Figure 2-7—WARC-92 Little LEOS Frequency Allocations**




a Downlinks are subject to coordination according to Resolution 46 if they exceed Certain power levels.
b Secondary in more than 70 countries. See footnote 608Z.
c User terminals have power limits to avoid interference across national boundaries.
d Use of the 149.9-150.05 MHz band is limited to land systems, and remains secondary until January 1, 1997.

NOTE: The coordination procedures outlined in Resolution 46 apply to LEOS systems operating in any of these bands.

SOURCE: Office of Technology Assessment, 1993.

> of the fixed or mobile services in the following countries [more than 70 out of the ITU's 166 countries are listed]. . . .[101]

Coordination between LEOS uplinks and the domestic services in these countries will be required.

In addition to the proposals made by the United States, WARC-92 allocated additional frequencies for little LEOS operations. The band 149.9-150.5 MHz, which is limited to land mobile use, will be shared on a co-primary basis with radionavigation-satellite services. Any LEOS service in this band may not constrain the radionavigation services, and will be on a secondary basis until Jan. 1, 1997. In response to proposals made by the Russian Federation, a secondary allocation was adopted for MSS in the bands 312-315 MHz (uplink) and 387-390 MHz (downlink), which can be used for non-geostationary systems. Any little LEOS system will have to share these bands with freed and mobile services, and cannot cause interference to existing services.

Finally, WARC-92 adopted Resolution 46, which outlines interim procedures for introducing and coordinating LEOS systems with existing services. Each of the bands allocated for use by little LEOS is subject to the procedures and limitations contained in Resolution 46, which will remain in effect until permanent procedures and regulations are adopted at a future world radio conference. As noted above, in the 137-138 MHz and 400.15-401 MHz bands, coordination is required only in cases where the signal power of a satellite received at the Earth exceeds a certain level.[102]

## DISCUSSION

Domestic Background—Prior to WARC-92, four companies applied to the FCC to build little

---

101 ITU, *Addendum and Corrigendum*, footnote 608Z, op. cit., footnote 61, p. 1.

102 The limit is -125 dBW. This limit may be changed by a future conference if it proves either too restrictive for LEOs or does not offer enough protection to existing services. Since none of the LEOS systems are operational yet, determiningg exact power requirements and sharing criteria is extremely difficult. As systems are implemented, and levels of interference can be measured and analyzed, these requirements and criteria may change. Special note is also taken to protect radio astronomy services in nearby bands.

## Box 2-D—U.S. Little LEOS Applicants

Three companies have applied to the FCC to build LEOS systems supplying messaging, data communication, and position determination services: Orbcomm, Starsys, and VITA.[1] Each of these applicants has been granted a license to build and operate an experimental system. Below are snapshot descriptions of the three little LEOS systems.

**Orbital Communications Corp.** (Orbcomm)—a subsidiary of Orbital Sciences Corp., Orbcomm's system would consist of 24 satellites orbiting the Earth in three planes at 785 kilometers. The system will provide three basic types of service: one-way emergency alerting, such as leak detection or medical alerts; one-way location services for cars, trucks, ships, or individuals; and two-way messaging and data communication. Orbcomm expects to serve a variety of user terminals ranging in cost from $50 to $400 in addition to a monthly subscription price of $5 to $45/month and individual usage charges. Total cost of the system is estimated at $100 million. The service is expected to begin operation in 1993, and be fully operational in 1994-95.

**Starsys, Inc.**—jointly owned by ST Systems Corp. and North American CLS (Collecte et Localisation par Satellite), a wholly-owned subsidiary of CLS of France.[2] The Starsys system will use 24 satellites orbiting at approximately 800 miles. Like Orbcomm, Starsys plans to offer a variety of data messaging and location information services, including emergency alerts, worldwide paging/messaging and (vehicle) fleet tracking. These services will not be available to consumers directly from Starsys, but through "customer service bureaus," which will buy capacity from Starsys and resell it to end users. Cost of the Starsys user terminals will vary from $75 to $250 depending on functions, with expected annual charges estimated at $150 in addition to usage charges. The Starsys experimental system began operation in August 1992, and an "Early Entry Program" using existing satellites is already being offered to businesses. The fully operational system is expected to cost approximately $200 million and be operational by 1995 at the earliest.

**Volunteers in Technical Assistance (VITA), Inc.**—is a nonprofit organization that provides technical information and assistance to developing countries. VITA's system is technically different than either Orbcomm or Starsys in that it plans to operate two satellites in fixed orbits serving approximately 1,000 stationary ground terminals. The system will be managed by a single control center near Washington, DC, and will not use regional gateways. VITA plans to provide data transfer services to developing countries, allowing users to transfer technical information as well as provide disaster relief services. Each VITA satellite is expected to cost $1.0 to $1.5 million, while the cost of the ground stations is estimated to be $4,000 to $6,000. VITA's experimental system has been operating since 1990, and the fully operational system is expected to be completed by 1996. Usage fees have not yet been set.

[1] A fourth company, Leosat, Inc., applied for a license to build a system, but its application was dismissed on procedural grounds. Leosat filed for reconsideration of its application, but that appeal was denied.

[2] There is some question over who controls Starsys, Inc. North American CLS owns 95 percent of Starsys, Inc., and the other 5 percent is owned by ST Systems Corp. Because of this split, Starsys' opponents, especially Orbcomm, maintain that Starsys is really a French company, with direct ties to the French Government, and should be prohibited from receiving a license to operate in the U.S. according to the Communications Act of 1934 (47 U.S.C., section 310). However, Starsys has already been granted an experimental license by the FCC—setting a precedent that will be difficult to reverse. No final determination on Starsys eligibility has yet been made by the FCC, although it will have to address the issue before granting Starsys an operating license.

SOURCE: Office of Technoloyg Assessment, 1993.

LEOS systems: Leosat, Inc.; Orbcomm, a subsidiary of Orbital Sciences Corp.; Starsys, jointly owned by ST Systems and North American CLS (Collecte et Localisation par Satellite); and Volunteers in Technical Assistance (VITA), Inc. (see box 2-D).[103] These companies were active in

[103] Leosat's application was dismissed by the FCC on procedural grounds. Leosat appealed the dismissal, but was denied in January 1993.

promoting U.S. proposals for little LEOS both before and at WARC-92.

The rivalry between these companies before the conference was intense, particularly between Starsys and Orbcomm and between Leosat and the others. Each challenged the other's technical plans and system configuration. Orbcomm also raised serious questions about possible foreign (government) ownership of Starsys, a factor that would make Starsys ineligible for a U.S. license under section 310 of the Communications Act of 1934.[104] Starsys, while acknowledging French interests in the company, maintains that U.S. concerns control the board of directors, thus making the company eligible for a license. The FCC has so far declined to rule on Orbcomm's accusations, and is proceeding with its actions.[105] Although the issue has not been resolved, the FCC has already awarded Starsys an experimental license. This may be in violation of the Communications Act, which makes no distinction between experimental and operational licenses. Observers point out that by awarding the experimental license, the FCC may have created a precedent that will be hard to reverse.

WARC Negotiations—WARC delegates credit much of the success of the little LEOS proposals to the work done prior to the conference by U.S. representatives traveling to other counties to explain the LEOS concept, how it works, and what the benefits could be. In many cases, this work was undertaken by individual representatives of the little LEOS proponents on behalf of their own or their clients' systems. Little LEOS proponents worked hard to educate individual countries on the specifics of little LEOS systems, seeking to allay those countries' concerns that these services would interfere with their existing uses of the band. At least some of this preconference work was done outside the framework of the official bilateral or multilateral talks the U.S. Government held with many countries.

Some observers have noted that U.S. Government representatives initially did not discuss little LEOS in meetings with foreign countries. Several possible reasons for this relative lack of interest on the part of the government have been noted. First, little LEOS were not one of the highest priority items for the United States. A second rationale that has been advanced is that some government interests were not happy with the bands that had been chosen for little LEOS and would have been happier if the bands were not allocated at all. An additional explanation is that the government representatives who participated in these initial preconference meetings did not have the expertise to discuss little LEOS topics in detail. These theories are reinforced by the fact that few industry people were involved in early negotiations.[106]

Just before WARC-92 convened, Ambassador Jan Baran brought together the little LEOS proponents to address the heated rivalry among the proponents during the preparation process in the United States. These meetings laid the groundwork for successful cooperation among the little LEOS applicants at WARC-92. At the conference, private sector representatives played an important role in building support for U.S. proposals and relaying status reports to government spokesmen and delegation leaders. Communication between these two groups was reportedly very good, and paid substantial benefits in rebuffing attempts by the Russian Federation and French delegations, among others, to limit little LEOS allocations.

At WARC-92 some, especially European, countries, were extremely protective of existing serv-

---

104 47 U.S.C.A., section 310.

105 Federal Communions Commission, Tentative *Decision in the Matter of Request for Pioneer's Preference in Proceeding to Allocate Spectrum for Fixed and Mobile Satellite Services for Low-Earth Orbit Satellites,* FCC 92-21, released Feb. 11, 1992, p, 5.

106 It should be noted that little LEOS applicants did participate in many of the multilateral meetings that were held prior to WARC-92, including various CCIR meetings and the CITEL WARC-92 preparation meetings.

**Table 2-3—Chronology of Little LEOS Actions**

| | |
|---|---|
| September 1988. . . . . | Volunteers in Technical Assistance (VITA) files application **for experimental LEOS system.** |
| **February-October 1990. . . . . .** | **Orbcomm, Starsys, VITA, and Leosat file applications to construct LEOS systems.** |
| **October 1991 . . . . . .** | **FCC releases Notice of Proposed Rulemaking on establishment of little LEOS service and allocation of frequencies.** |
| **January 1992. . . . . .** | **FCC awards pioneer's preference to VITA.** |
| **March 1992. . . . . .** | **WARC 92 adopts allocations for little** LEOS systems. |
| April 1992. . . . . | FCC issues experimental licenses to Orbcomm and Starsys.[1] |
| | FCC asks for comments on establishing an advisory committee **for little** LEOS. |
| | Leosat application dismissed. |
| May 18, 1992. . . . . | Orbcomm, Starsys, and VITA file joint comments proposing new little LEOS **rules.** |
| July **23, 1992. . . . . .** | **FCC establishes an advisory committee for little LEOS (official title: "Below 1 GHz Negotiated Rulemaking Committee").** |
| **August 10, 1992. . . . . .** | **First meeting of little LEOS advisory committee.** |
| **September 16, 1992. . . . . .** | **Last meeting of little LEOS advisory committee.** |
| **January 1993. ., . . . . . .** | **FCC allocates frequencies to little LEOS, and proposes technical rules to govern little LEOS systems.** |

[1] VITA has held anexperimental license since 1989.

SOURCE: Office of Technology Assessment, 1993.

ices, and wanted to constrain little LEOS operations as much as possible. This opposition accounts for the adoption of footnote 608Z, which limits little LEOS to secondary status in many countries in the 148- 149.9 MHz band. Although not ideal, this allocation was apparently acceptable to the three U.S. proponents. U.S. representatives were successful in reaching out to many developing countries and convincing them to support the U.S. proposals.

Post- WARC *Activity—Domestic Actions:* Once allocations were made by WARC-92, efforts to launch little LEOS systems moved back to the United States and into high gear. The FCC took an aggressive approach toward implementing the little LEOS systems (see table 2-3); issuing experimental licenses to Orbcomm and Starsys, granting a pioneer's preference to VITA, and establishing an advisory committee to help it establish the rules and regulations that will govern little LEOS systems (see appendix E). The FCC's proceeding on the frequencies to be used by little LEOS concluded in January 1993, when the FCC adopted the allocations proposed at WARC-92 as the domestic allocations for little LEOS services, At the same time, the FCC proposed rules, based on the results of its negotiated rulemaking process, to govern little LEOS services.

After WARC-92 ended, the little LEOS companies, partners at WARC-92, once again became rivals. As before, some of the most contentious issues surrounding the implementation of little LEOS services are those that involve technical challenges and protests the companies have leveled against each other. It should be noted, however, that the companies (Orbcomm, Starsys, and VITA) were able to put aside their differences long enough to work out proposed service rules and sharing arrangements to submit to the FCC.

*International Interest: On the* international front, interest in little LEOS has been strongest among the developing countries, who see satellite communication as an important way to reach areas with inadequate or no communication services. As of early 1993, at least three other countries were actively developing little LEO systems, France's Centre National d'Etudes Spatiales (CNES-the French equivalent of NASA) has already launched the frost satellite in a

proposed little LEOS system called Taos. Although currently not funded, the concept for the full system calls for six satellites to be operational in 5 years serving up to 1.5 million users worldwide.[107] In Mexico, LeoSat Panamericana has begun experiments and plans to begin offering services in 1995.[108] Smolsat—a consortium of space companies based in the Russian Federation—has already launched the first six LEOS (two of which are for commercial use) of a proposed 36-satellite system known as "Gonets."[109] Beginning in 1995, the system plans to provide high-speed data services including electronic mail and fax transmission serving transportation and other industries. The Gonets system plans to add intersatellite links in 1997, enabling voice services to be provided globally, at a total cost of $300 million. Although this system will not compete with U.S. little LEOS providers for the same spectrum, it could compete with U.S. system (s) to provide the same types of services around the world.[110]

## ISSUES AND IMPLICATIONS

**WARC-92** significantly boosted the prospects for little LEOS technologies and services. However, several obstacles remain, and difficult issues must be resolved before little LEOS services become available throughout the world. Services are expected to be implemented frost in the United States and then spread to other countries. Current plans call for U.S. services to begin sometime in 1994.

Sharing Concerns--The most important issue facing little LEOS proponents involves interference and sharing. Sharing concerns have several dimensions. First, the new little LEOS systems must share with the existing users of the frequencies, both domestically and internationally. This is likely to be the largest problem standing in the way of the implementation of little LEOS services. The frequencies in which the little LEOS will operate are already used by some countries, including the United States, for space operations and research and meteorological services (in 137-138 MHz and 400.15-401 MHz), and various point-to-point and mobile applications (in 148-149.9).[111] In order to protect existing services, WARC-92 limited little LEOS to secondary status in parts of the 137-138 MHz band (see figure 2-7), limited power levels, and, as noted above, more than 70 countries downgraded little LEOS to secondary status in their countries in the 148- 149.9 MHz (uplink) band. The latter declaration could cause serious difficulties for potential little LEOS service providers if foreign governments are unwilling or unable to coordinate the LEOS uplinks with their own uses.

Domestically, U.S. Government agencies want to protect their existing services from harmful interference by little LEOS. The National Oceanic and Atmospheric Administration (NOAA), for example, operates weather satellites in the

---

107$ 'French Hope to Launch Global Data-only Mobile Communications System," *Space Commerce Week,* vol. 9, No. 40, Oct. 19, 1992.

108 Plans for LeoSat Panamericana's system call for 24 satellites serving Latin America. It will offer the same types of data messaging and paging services as the U.S. LEOS companies. Manuel Villalvazo, "LeoSat Panamericana: Latin American Communications on the Move," *Satellite Communications,* November 1992.

109 "Russian Firms Launch Initial Satellites of LEO System," *Satellite News,* July 27, 1992, p. 5.

110 The Russian system will use 312-315 MHz for its downlinks and 387-390 MHz for uplinks. Both bands are allocated to MSS on a secondary basis, and must share with existing fixed and mobile services. Because these bands are used for Defense Department communications, the system will not be allowed to operate in the United States.

111 Radio astronomy interests are also particularly concerned about possible interference from little LEOS into their space observing instruments. Although these instruments operate in slightly higher frequencies (150.05-153 MHz and 406.1-410 MHz), use of radio frequencies is not precise and often can spill over into adjacent channels. Radio astronomers fear that little LEOS operations will spill over into their frequencies and disrupt their receiving equipment, which is very sensitive. This prompted WARC-92 to adopt language in footnote 599A that instructs countries to "take all practicable steps to protect the radio astronomy service in the 150.05-153 MHz [and 406.1-410 MHz] band from harmful interference. . . ."

137-138 band. Discussions have already begun to coordinate the use of these frequencies. The 148-149.9 MHz band is currently allocated domestically only for government (military) use. The Air Force, for example, plans to extend its meteorological satellite system in the 400 MHz band.

International sharing may also be difficult due to the existing uses of the bands and the degree of opposition to the U.S. proposals, especially in the 137-138 MHz and 148-149.9 MHz bands. Canada, for example, although it supported other U.S. little LEOS proposals, joined footnote 608 Z---making little LEOS secondary in Canada. This action was taken in order to protect its extensive paging operations in the 148-149.9 MHz band. Because these systems have to penetrate buildings to ensure complete coverage, they are also very high power, and since they are often concentrated near the U.S. border, coordination between Canada and the United States will be necessary. These uses must be taken into account by little LEOS proponents as they design their systems and by the FCC as it implements rules governing little LEOS services.

The secondary status of LEOS operations in some bands is an important concern for potential little LEOS providers, both at home and abroad, While the effects of these limitations are not known, since the services are not yet operational, they are potentially serious. Secondary status makes sharing with existing users more complicated, and coordination issues become more difficult, although probably not insurmountable.

Little LEOS providers maintain that they can operate within these limitations, but the real possibility exists that the primary services in the bands, especially the fixed and mobile services in the 148-149.9 MHz band could overwhelm them. As long as this secondary status exists, little LEOS services will remain threatened, potentially dampening investment in these systems and retarding development. Despite such difficulties, each company is moving ahead with its negotiations for foreign licenses.[112]

The second major sharing concern facing the competing little LEOS providers is that they must share the newly allocated spectrum among themselves. Although the spectrum allocated to little LEOS is limited, the FCC has stated its intention to allow as many providers as possible to use the bands, and is committed to having at least three competing providers. Indications are that this sharing can be accomplished among the existing applicants, However, it is less clear how potential future providers will be accommodated in the bands. It is possible that future applicants-both domestic and foreign—may have a difficult time using spectrum that has already been divided up between the three U.S. companies. This is an important concern in foreign countries considering launching their own systems. The EC's Communications Directorate has requested talks with the United States to discuss its concerns that the U.S. systems not become *de facto* standards/ monopolies in the little LEOS bands (see section on big LEOS below). The FCC's negotiated rulemaking proceeding did not resolve these questions, but they are expected to be addressed by the FCC in its upcoming NPRM on the little LEOS service rules and licensing procedures. A final resolution of this issue may have to wait until systems are operating and real usage and interference levels can be measured.

International Licensing—The question of international licensing of little LEOS systems is crucial. Little LEOS providers will have to gain approval from every country in which they plan to operate.[113] The problem is that satellite footprints (the areas within which transmissions can be received) do not respect national boundaries—transmissions spill over borders, and systems

---

112 Orbcomm, for example, reports that it has agreements with 11 countries and is in negotiation with 11 more to establish its service.

113 Both uplink facilities (gateways) and user terminals will have to be licensed. The way this licensing is accomplished will depend on each country's regulations (and politics), and will have to be negotiated on a country-by-country basis.

cannot just be turned off at the border. In the worst case, if a country opposes the system, and refuses to license a LEOS system, the little LEOS services would technically be prohibited from operating in that country. For a concept that is premised on worldwide coverage, a patchwork of ''safe' nations in which the system can operate would be complex to engineer, and could undermine the economic viability of the system. Operating a LEOS system in an area such as Europe, for example, which has a number of very small countries, may make provision of service to some countries, but not others, (technically) very difficult.[114] Only one dissent from a country in a strategic geographic location could effectively preclude service for a number of countries.

Foreign countries will have several concerns over the licensing of little LEOS systems, and negotiations will be complex. Political, technical, and economic issues will all be in play, and the ability of the little LEOS providers to convince foreign countries to license such services will depend on several factors. First, all countries will want to protect their existing systems and applications that will be sharing the band with the new little LEOS systems. The little LEOS providers must convince these countries that their proposed systems either will not cause interference to existing services or can be engineered to share the spectrum with them.

Secondly, the contractual obligations of the licensing country and the service provider will have to be delineated. European nations especially are concerned that little LEOS systems may siphon use (and hence revenues) away from the public telephone network—an important source of revenues they want to protect. Many issues will be considered: Who will build and pay for any required infrastructure in the country, such as a **satellite gateway** facility? How will revenues generated by these new services be distributed between the companies and the countries in which they operate? If a system is offering services in a country, that country could demand a portion of the revenues generated in return for licensing the system. If a country maintains a gateway to the system, revenue sharing would be easier to monitor than if a country is served by a gateway in a neighboring country. Such negotiations will have to be conducted on a country-by-country basis, a process that will be time-consuming and legally complex.

Finally, on a purely political level, the manner in which the FCC rules governing such services are written (and enforced), the ways the systems actually operate, and the dictates of the Communications Act of 1934 may have an impact on which countries support and license them. If other countries that may intend on launching their own little LEOS systems perceive that FCC rules are written and the initial U.S. little LEOS applicants will operate in such a way that inhibits other (foreign) systems from sharing the spectrum with them, those countries may refuse to license the U.S. systems. A potentially more significant problem has to do with section 310 of the Communications Act of 1934.[115] Under that act, licensing of companies owned or controlled by foreign nationals or governments is severely restricted. Other governments may be reluctant to grant U.S. companies licenses to operate in their country when foreign companies are not allowed to obtain licenses in the United States.[116]

Markets--The potential market for little LEOS-type services is large. However, several long-term questions remain that could limit the marketing appeal (and the revenue-producing ability) of little LEOS services. First, because of the limita-

---

114 Providing adequate signal levels in one country while still respecting the power limitations *in those* neighboring countries who have chosen not to license the service may require painstaking engineering design and coordination.

115 47 U.S.C.A. section 310.

116 This provision applies only t. the provision of common carrier, broadcasting, and some aeronautical services. In part to avoid this problem, Starsys has indicated that it will apply to the FCC to be licensed on a non-common carrier basis.

tions on little LEOS operations due to footnote 608Z, little LEOS services are not likely to become available in those 70+ countries in the near future. The effect of this footnote may eliminate Europe as a potential market. The question then becomes: can little LEOS survive on the markets that are left? The U.S. little LEOS applicants believe that they can. The size of the remaining markets, however, will determine that success or failure and as yet, the real demand for LEOS-type services is not well-known.

From a U.S. competitiveness perspective, footnote 608Z may actually be positive. Because the footnote made LEOS a secondary service in Europe it also effectively excludes European companies from launching competitive systems. With only a secondary allocation, it is extremely unlikely that any European companies would build (or find support to build) such a system. Even if a system were built, it would likely take many years of negotiations, and some countries might have to renounce footnote 608Z. By the time this occurred, one or more U.S. systems would already be operating and would have a substantial jump on the market and an installed base of customers and equipment.

The most serious marketing problem for the little LEOS will likely be competition from other mobile data service providers. In the United States, terrestrially-based data communication systems, such as Ram Mobile Data, Ardis, and CoveragePlus, as well as private systems, are already providing mobile data services in most large urban markets. In addition, Qualcomm's OmniTracs system is already serving the Nation's trucking companies with nationwide position location and data messaging services.[117] The installed base of customers and equipment could make it difficult for little LEOS to attract sufficient customers to be profitable.

In addition to these established companies, little LEOS systems may also face competition from the proposed big LEOS systems, which plan to offer data services in addition to their primary voice service. While little LEOS services could be less expensive than similar services provided by big LEOS, it is possible that big LEOS will be able to match service prices since the cost of providing data services (in addition to their core voice service) will likely be nominal. Many consumers may want (and be willing to pay for) voice services instead of data-only services. On the other hand, little LEOS services may undermine the big LEOS (data and messaging) services, due to their lower costs and earlier implementation.

The current rush to put little LEOS services into operation represents a desire on the part of the applicants to get such systems into operation as soon as possible in order to capture the unmet needs of today's consumers and businesses. If a large enough market can be captured initially, before big LEOS come into operation, little LEOS systems could become and remain profitable. However, if their services do not achieve adequate levels of market penetration quickly, and if their costs are too high, little LEOS survivability in the face of competition from big LEOS maybe questionable.

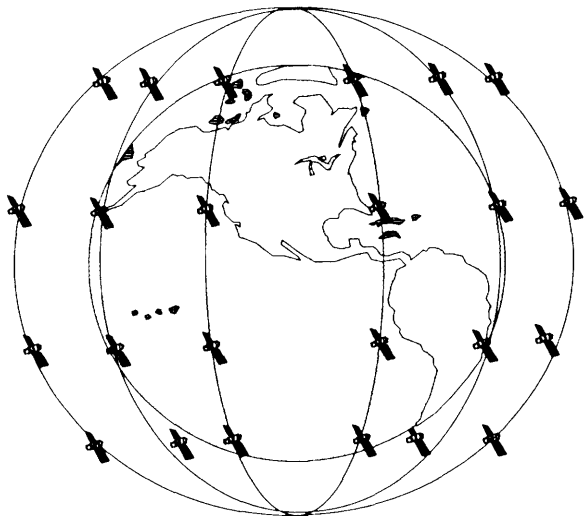
As a result of such pressures, little LEOS systems may be reduced to serving primarily rural areas or niche markets with special communication needs. Services, for example, could eventually be limited to business applications, such as vehicle location and traffic management services, fleet management services for freight companies, and data communication services for service personnel or emergency relief agencies.

Technology and Cost Considerations-As with all low-Earth systems, little LEOS satellites will have to be constantly replaced as older satellites reach the end of their lifetimes (approximately 5 to 7 years).[118] This means that for as long as the system operates, new satellites will have to

117 "Will LEO Allocation (@m Door to Mobile Data, AVL Competition?" *LundMobile Radio News,* vol. 47, No. 4, Jan. 22, 1993.

118 NASA has also raised the possibility that existing space debris may pose a threat to LEOS systems.

**Figure 2-8-Low-Earth Orbit Satellite System**



**This generic low-Earth orbiting satellite system demonstrates how such systems can achieve near-worldwide coverage. The actual systems have orbits that differ in altitude, number of satellites in orbit, number of orbital planes, and shape of the orbit.**

**SOURCE: Office of Technology Assessment, 1993.**

be designed, built, and launched on a continuing basis. Some have likened this to an assembly line for satellites. As a result of this long-term commitment, several issues need to be recognized. First, the cost of constructing and launching the initial network of satellites is only part of the total cost of the system. Because satellites will have to be constantly replaced, revenues must also cover the ongoing costs of design, construction, and launching. These costs must be borne as long as the system is in operation. Given the marketing questions raised above, this could be a challenge. Second, although little LEOS systems do not necessarily need a full network of satellites to operate, access to services using less than the optimum number of satellites would be degraded. The system could operate, but some areas might receive poor coverage and the time when a user could actually contact a satellite would be reduced. If a string of launch failures occurs, any LEOS system will be in jeopardy.

## Big LEOS[119]

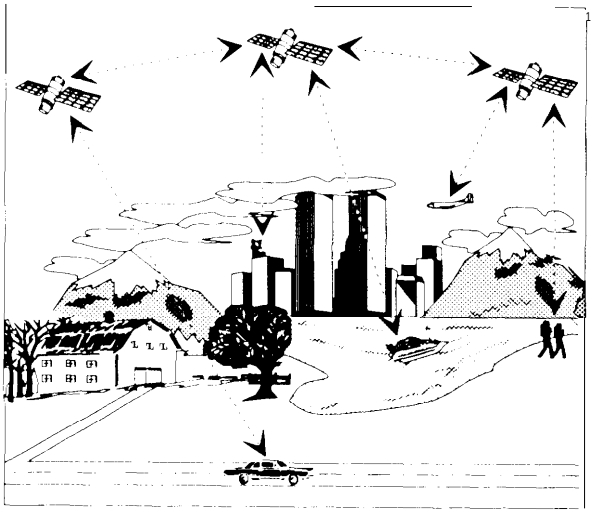
### BACKGROUND

In addition to the data and positioning services being developed by the little LEOS companies, another class of LEOS systems has been proposed that would provide telephone service almost anywhere in the world. These LEOS systems, which will operate in frequencies above 1 GHz, have been dubbed "big LEOS." Like the little LEOS, big LEOS systems will use a network of many satellites-from 12 to 66 depending on the type of orbit—to provide service around the globe (see figure 2-8). These satellites will be larger and more complex than little LEOS satellites, and, as a result of their added capabilities, will also be more expensive ($10 to $20 million). On the ground, control centers will administer the system and manage the satellites, and a number of gateway stations located in different countries will be connected to the public telephone network—allowing users to receive calls from and make calls to anyone with a (regular wired) telephone (see figure 2-9). One advantage of big LEOS over conventional geosynchronous satellite systems for phone service is that, because the low-Earth satellites are much closer to the Earth (generally less than 1,000 miles compared with more than 22,300 miles), they avoid the annoying delay in conversations caused by the long trip the signals have to make between the Earth and the geosynchronous satellite and back.

Big LEOS systems promise to provide voice and data communications where none exist now (in remote mountains, for example), or in coun-

119 Technically, the systems discussed in this section are not all *low*-Earth orbiting systems. TRW's Odyssey system, fOr e-pie, plans to use medium-Earth orbits, and Ellipsat plans elliptical orbits. As a result, official government terminology uses the term "non-geosynchronous' when referring to these systems. Because these systems have been colloquially referred to as ''big LEOS'' for several years, OTA will continue to use the term in this section to refer to all proponents for these types of systems.

**Figure 2-9-Generic Big LEOS System**



NOTE: Intersatellite **links will be used only by Motorola's Iridium system.**

**SOURCE: Office of Technology Assessment, 1993.**



Motorola, Inc.

*Dual-mode portable telephones, such as this prototype from Iridium, will first attempt to connect to a local cellular system. If no system can be accessed, the telephone will then use the satellite system to complete the call.*

tries in which the communications infrastructure is not well-developed. These satellite systems would allow such countries to connect their citizens with each other and to the outside world, while avoiding the high (often prohibitive) cost of building a wireline communications infrastructure. Other potential markets for big LEOS services include international tourists and business travelers, emergency relief organizations, government agencies, and various international associations,

### U.S. PROPOSALS

**The** big LEOS concept was first formally proposed after the topics for WARC-92 were finalized (see table 2-4). As a result, big LEOS were not specifically included in the WARC-92 agenda. However, prior to the conference, U.S. representatives were able to convince other ITU members that LEOS systems are only a different way of providing MSS, and should be considered as part of the MSS negotiations.

In anticipation of their inclusion in the WARC-92 debate, allocations for big LEOs were considered in the various U.S. domestic preparations processes, and in its final *Report* on WARC-92 proposals, the FCC! identified bands that it recommended for LEOS use. The FCC proposed:

- Upgrading MSS to primary status in 1610-1626.5 MHz (Uplink) and 2483.5-2500 MHz (downlink);
- Allocating through a footnote the 1613.8-1626.5 MHz band to MSS downlinks on a

**Table 2-4-Chronology of Big LEOS Actions**

| | |
|---|---|
| November 1990. . . . . | Ellipsat Corp. files application to contruct Ellipso I. |
| December 1990. . . . . | Motorola inc. files application to construct Iridium. |
| May 1991. . . . . | TRW, inc. files application to construct Odyessy. |
| June 1991 . . . . . | . Constellation Communications, Inc. files application to contruct Aries.<br>• Loral Qualcomm Satellite Services., Inc. files application to construct Globalstar.<br>. Ellipsat Corp. files application to construct Ellipso II. |
| July 1991-February 1992.. . . | Applicants file for Pioneer's Preference. |
| February 1992. . . . . | WARC-92 adopts allocations for MSS (big LEOS). |
| August 1992. . . . . | . FCC declines to grant Pioneer's Preference to any particular applicant.<br>. FCC grants experimental licenses to Motorola, Inc., Constellation Communications, Inc., and Ellipsat Corp.<br>. Notice of Proposed Rulemaking proposes allocations for big LEOS services.<br>. FCC releases public notice on negotiated rulemaking for big LEOS. |
| January-March 1993. . . . . | Big LEOS Advisory Committee deliberations. |
| Summer 1993... . . . . | Planned launch of experimental systems. |

SOURCE: Office of Technology Assessment, 1993.

secondary basis in order to permit bidirectional use of the band; 120 and

- Allocating through a footnote the 1850-1990 MHz band to MSS on a primary basis.[121]

In the initial U.S. proposals to the ITU, these recommendations were included as part of the MSS proposals, and although LEOS are not specifically mentioned, the proposals did note the use of MSS allocations for LEOS services, and U.S. intentions to use the bands for LEOS operations were made clear to foreign delegates prior to the conference.

## RESULTS

U.S. allocation proposals were relatively successful, but a number of footnotes limit the power the systems can use and prohibit big LEOS systems from causing interference to (some) other users of the band-effectively reducing big LEOS operations to secondary status in relation to those other users. Stringent coordination requirements were also adopted. These conditions were acceptable to U.S. big LEOS proponents, but they may be revisited in the future if they prove too restrictive. In summary, WARC-92 decided to:

- Upgrade MSS (including, but not limited to LEOS) to coprimary status at 1610-1626.5 MHz (uplink) and 2483.5-2500 MHz (downlink), subject to the coordination procedures specified in Resolution 46 (see below).[122] In order to protect the services currently using the band, WARC-92 set limits (according to footnote 731X) on the power the mobile telephones can use. This footnote also prohibits MSS operations from interfering with aeronautical navigation and freed services, including the Russian GLONASS satellite navigation system (see box 2-E). Users of big LEOS mobile telephones cannot interfere with or claim protection from these existing services. This provision effectively makes MSS/big LEOS services secondary to these other services, even

120 This proposal responds directly to the plans of Iridium to use the band fOr two-way communication.

121 In order to preserve flexibility, no direction (uplink or downlink) was specified for this band.

122 User handsets transmitting up t. a satellite cannot exceed specific power levels that vary according to whether or not the frequencies will be shared with the Russian satellite navigation system, GLONASS. For signals being transmitted down from LEO satellites, WARC-92 set a ''trigger" level—if the power of the signal exceeds that level, LEOS systems would have to coordinate with existing users. If the signal's power remains under the limit, however, no coordination is required.

## Box 2-E—GLONASS

GLONASS is the global satellite navigation system that is being developed by the Russian Federation. When completed in 1996, GLONASS will consist of a constellation of 24 satellites circling the Earth in three orbital planes. It will provide position location and navigation services to cars, trucks, ships, and individuals. Currently, there are 14 satellites in operation, and 9 more awaiting launch. Together with the U.S. Global Positioning System (GPS)[1], GLONASS is expected to form the basis for implementing the future Global Navigation Satellite System (GNSS) concept.[2] The civil aviation industry is currently examining the potential of such a system for increasing safety and efficiency as part of a Future Air Navigation System (FANS) concept.[3]

U.S. aviation interests have been working with USSR and Russian Federation representatives for some years to analyze the potential of coordinating the GPS and GLONASS systems and develop the details of a coordinated system. Many elements of the systems have already been finalized and would be very difficult to change at this late date in the process. Representatives from Russia have participated in some of these activities and have reportedly provided helpful input for the work of the U.S. groups.[4] In addition, the United States has a study group (International Radio Consultative Committee National Study Group 8-D) chaired by NTIA looking at the issues involved in coordinating GPS and GLONASS.

[1] There are 20 operational GPS satellites serving over 100,000 boaters worldwide. The system also was extensively used during Operation Desert Storm. When completed in mid-1993, the system will consist of 21 operational satellites and three in-orbit spares. The total cost of the system, including building and launching the satellites and developing the receivers, will approach $8 billion by the year 2000. William Harwood, "GPS Satellite Launches Resume After Hiatus," *Space News*, vol. 3, No. 8, March 2-8, 1992; and Debra Polsky, "Ground Stations to Correct GPS Inaccuracies," *Space News*, vol. 3, No. 18, May 11-17, 1992.

[2] Current concepts of GNSS envision the two systems supplementing each other rather than operating as one integrated system. Equipment on airplanes would be capable of receiving, combining, and processing signals from both systems. Although the systems could operate independently (and, in fact, were originally designed that way), by utilizing both systems, it is believed that GNSS will be more accurate and reliable than either system could be on its own. Each system will be able to back the other up, thereby eliminating holes in the coverage of one system or the other. Two systems also increases reliability because of the ability to cross-check between them. Finally, use of the two systems may also improve accuracy because the GLONASS signal is not purposely degraded as is the DoD-controlled GPS.

[3] However, there are some in the airline industry who would prefer to build a completely new GNSS from scratch rather than rely on a DOD-controlled system that will be free, but only for 10 years. Robina Riccitiello, "Civilian GPS Users Eye Future System," *Space News*, vol. 3, No. 18, May 11-17, 1992.

[4] There are at least three forums in which GPS/GLONASS coordination activities are underway: the Airlines Electronics Committee has already developed standards for a combined GPS/GLONASS receiver, RTCA has a special committee (SC-159) that is developing the sole means navigation concepts for GPS, and the Department of Transportation has an agreement with the former USSR to develop international receiver standards for GPS/GLONASS. Russian representatives have been active in all these forums to varying degrees. Larry Chesto, Director, Telecommunications Systems, Aeronautical Radio, Inc., personal communication, July 7, 1992.

*(Continued on next page)*

though MSS services technically have a primary allocation.

- Adopt a secondary allocation for MSS downlinks at 1613 .8-1626.5 MHz, subject to the conditions of Resolution 46.[123] This allocation allows the 1613.8 -1626.5 MHz band to be used for bidirectional communication between the users and the satellites.
- Elevate the Radio Astronomy Service to primary status in the 1610.6-1613.8 MHz band.[124] In addition to this upgraded status, WARC-92 also modified footnote 733E to

123 Power limits apply to the 1 6 138.1626.5 MHz secondary allocation, but LEO systems will have to coordinate regardless of power level.

124 I„ this band, aeronautical radionavigation, radiodetermination-satellite, MSS, and radioastronomy all share primary status.

## Box 2-E—GLONASS—(Continued)

The GLONASS system presently operates in the 1596.9-1616 MHz band. However, the Russian Federation has notified the International Frequency Registration Board (IFRB) that it intends to introduce an expanded GLONASS-M system that will operate in the 1596.9-1620.6 MHz band. This will complicate and/or limit the use of the band by LEOS systems, by making coordination necessary in a larger portion of the band. The implementation of the GLONASS-M system may cause special problems for Iridium, which has said it will only operate in the portion of the band that GLONASS does not use. The full GLONASS-M system would limit Iridium to approximately 6 MHz (1620.6-1626.5 MHz), an amount of spectrum which may not be sufficient for the system to operate. However, the United States and more than 20 other countries have filed objections to the proposed rollout of the GLONASS-M system, and it has yet to be coordinated under ITU rules.[5]

In addition to the big LEOS systems that plan to use this band, radio astronomers have been using the band for years to support their research on the universe. They have long protested the GLONASS system because of the interference it could cause to very sensitive operations at 1612 MHz. The United States is a world leader in radio astronomy research, and U.S. spectrum managers and radiocommunication policymakers will have to find a way to accommodate the needs of both the aviation and scientific communities.

Although there is some dispute about what U.S. representatives knew about GLONASS-M and when, it nevertheless appears that U.S. delegates were caught off guard by the announcement of GLONASS-M. The then-USSR had previously filed with the IFRB for a satellite system that would occupy the band 1597-1616 MHz. These are the bands the big LEOS proponents and the government had accounted for in their planning. However, these bands were apparently tentative because Russia, at the beginning of WARC-92, indicated that it intended to expand the frequencies used by the system so that the full GLONASS-M system would operate in the range 1596.9-1620.6 MHz. Such an expansion and use is in accordance with the international Table of Frequency Allocations, which permits such operations up to 1626.5 MHz.

Complicating the picture for U.S. interests is the uncertainty surrounding the future of GLONASS itself. Due to the political and economic turmoil in the former USSR, there is some concern in the United States that GLONASS may not survive or its full implementation could be delayed. A total of 20 of the initial satellites are already built, but the short lifespan of the satellites means that the continued viability of the system will depend on a continual replenishment of satellites, and a continual drain on Russian resources.

---

[5] The original GLONASS system has been coordinated internationally under ITU rules. The fact that this coordination has been completed gives the system some protection from interference as specified in footnote 731X. This same protection, however, does not apply to the frequencies planned for use by the GLONASS-M system. Unless and until the system is coordinated internationally, which seems unlikely given the opposition already filed against it, the frequencies (1616-1620.6 MHz) will not be protected from interference. This gives some hope that U.S. big LEOS systems will be able to use these frequencies.

SOURCE: Office of Technology Assessment, 1993.

prevent harmful interference to radio astronomy services from MSS and radiodetermination-satellite services.

The U.S. proposal for the 1850-1990 MHz band was not accepted. However other additional spectrum was allocated to MSS which could be used for LEOS services (see section on the Mobile-Satellite Service, above).

WARC-92 also adopted Resolution 46 to establish interim procedures for announcing and coordinating new non-geostationary satellite systerns. Because these systems are still being developed, their technical parameters are not final, and the methods for sharing spectrum between new LEOS services and existing (terrestrial and space) services have not yet been

developed. These interim procedures were adopted to allow the ITU adequate time to study the problems and develop appropriate sharing criteria. In the meantime, LEOS systems can be deployed, allowing engineers to gain practical experience and knowledge about what service rules and interference criteria will be required to enable systems to share the spectrum. Permanent regulations governing sharing will be adopted by a future conference called for in the resolution.

## DISCUSSION

Domestic Background—Ellipsat Corp. and Motorola, Inc. first formally proposed LEOS systems providing voice communications in late 1990--too late to be included in the formal agenda of WARC-92 (see table 2-4). Shortly thereafter, three additional applicants--Loral Cellular Systems Corp., Constellation Communications, Inc., and TRW, Inc.— applied to the FCC to construct other big LEOS systems (see box 2-F for a description of the big LEOS applicants and table 2-5 for a comparison of their systems).[125] Despite their lack of formal standing on the WARC-92 agenda, big LEOS quickly became one of the focal points of U.S. proposals and preconference negotiations. U.S. companies have historically been very strong competitors in satellite communications, and the emergence of the big LEOS concept before the conference presented the United States with an important opportunity to extend its lead in satellite technology and services and shore up its role in mobile technology, which many observers believe is slipping given European progress in implementing GSM.

Two basic concepts were originally proposed for big LEOS systems (see figure 2-10). In the simpler of the two, proposed by all the firms except Motorola, the LEOS would function primarily as relays in the sky. A user would place a call through the LEO satellite, which would then transmit it to the nearest Earth gateway station for connection through the long distance and local lines of the public telephone system. No switching between satellites would be required.

Motorola's Iridium system, by contrast, is much more complex. It was first designed as a satellite-only system in which a caller would send his/her call to the satellite, which would then pass it from satellite to satellite until it reached the satellite closest to the intended recipient of the call. That satellite would then transmit the call to the intended person's portable phone, or relay the call through the public telephone network via a network gateway station.[126] Because of the intersatellite linking and switching that Iridium requires, the system requires sophisticated satellites and software to control it.

In response to concerns by U.S. telephone and cellular providers and criticism from foreign telephone companies that satellite-only phones would bypass foreign telephone systems and deprive them of valuable telephone revenues, all the big LEOS proponents began developing "dual-mode" handsets-mobile telephones that will be capable of using either cellular or satellite systems.[127] The phone will frost attempt to connect to a local cellular system. If the user is not in an area with cellular service, or is out of range of the nearest system (or if the terrestrial system is busy), the phone will then connect to the satellite network. Dual-mode handsets will resemble today's portable cellular telephones, and are expected to cost from $500 to $3,000.

---

125 AMSC also applied to the FCC for permission to construct a system using the same bands, and is participating in the negotiated rulemaking regarding big LEOS systems.

124 Since its original introduction, Motorola has refined this concept in response to criticism that such a system would bypass existing telephone systems, an unacceptable outcome to many foreign (and U. S.) governments and telephone companies. See the discussion of "dual-mode" phones below.

127 Foreign telephone companies have some leverage over U.S. companies because they are often owned by or closely allied With their governments-who control frequency allocations the U.S. companies need to operate.

## Box 2-F—LEOS Systems Using Frequencies Above 1 GHz

The development of a new generation of wireless communications services has been sparked by recent advance in the technology of low-Earth orbiting satellites. In 1990 and 1991, five U.S. firms applied at the FCC to construct LEOS systems. At WARC-92, the international telecommunication community allocated certain sections of the frequency spectrum to be used by LEOS systems worldwide.

These systems plan to offer telephony, data, and position determination to a target market that includes cellular telephone users, nations with underdeveloped telecommunication systems, and international travelers, business people, and organizations. Systems will use an integrated combination of LEOS, terrestrial gateway stations, dual-mode handsets and existing cellular systems and the public telephone system to deliver services.[1] Although the services they plan to offer are similar, each of the proposed big LEOS systems are technically different. The five U.S. systems currently under development are:

1. **Iridium, Iridium Inc.**—Originally, Iridium proposed a constellation of 77 satellites. However, after receiving an FCC experimental license in August 1992 the system has been modified to include only 66 satellites placed in a circular orbit at an altitude of 421.5 nautical miles in 6 polar orbits (11 satellites in each orbital plane). Transmission will be provided through a time division multiple access modulation scheme, and will use the L-band frequencies allocated at WARC-92 for both up- and downlinks. Users will be able to communicate through portable, dual-mode handsets that will either connect to existing cellular service, if available, or through its unique satellite linking system. The estimated cost for the handset is $3,000 and $3.00/minute for service use. Company officials expect that Iridium will be fully operational by 1998 at a cost of $3.37 billion, the highest of the five proposed systems.
2. **Aries, Constellation Communications, Inc.**—Aries plans a worldwide LEOS system that is projected to reach 2.9 million subscribers by the year 1996. It will use a constellation of 48 satellites orbiting at 550 nautical miles, transmitting through a handset that will cost approximately $1,500. Aries has proposed a CDMA modulation scheme and will use the L-band frequencies for uplinks and S-band frequencies for downlinks. In August 1992 the FCC awarded Aries an experimental license, and the expected launch date of the first satellite is summer 1993. The total projected operational cost of the Aries system is $292 million.
3. **Globalstar, Loral/Qualcomm Satellite Services, Inc.**—Globalstar will initially operate with a smaller constellation of 24 satellites for continental U.S. coverage. As international market demands and authority is granted, an additional 24 satellites will be deployed to expand Globalstar coverage worldwide. Satellites in this system will orbit the Earth at 750 nautical miles. Globalstar has also proposed a CDMA modulation scheme and will use the L-band frequencies for uplinks and S-band frequencies for downlinks. Transmission is achieved through the use of two types of relatively inexpensive handsets-single mode or dual mode. Price of the units is expected to be $700 when produced in mass market quantities. Globalstar expects to be fully operational by 1998 at a total cost of $829 million.
4. **Ellipso, Ellipsat Corp.**—Unlike other big LEOS systems, Ellipso requires a constellation of 24 satellites orbiting in an elliptical pattern, only offering service to the U.S., including Hawaii, Alaska and other U.S. territories. Ellipsat has also proposed a Code Division Multiple Access (CDMA) modulation scheme and will use the L-band frequencies for uplinks and S-band frequencies for downlinks. It expects to be partially operational by mid-1994 and fully operational by 1997 at a total cost of approximately $410 million. The Ellipso handset is expected to cost $1,000 for a new unit or $300 for an add-on to an current cellular handset. The estimated service subscription for Ellipso is $.50 per minute.
5. **Odyssey, TRW, Inc.**—The Odyssey system plans to offer service to North America alone, utilizing a constellation of 12 satellites operating in the L-,S-, and Ka-bands. The satellites will orbit at an altitude of 5,600 nautical miles, substantially higher than the other systems. Some have labeled this a medium-Earth orbiting satellite system (MEOS). User handsets will be dual-mode, and are expected to cost approximately $1,000 once economies of production are realized. TRW, Inc. expects Odyssey to be fully operational by mid-1996, at a cost of more than $1.3 billion.

[1] Iridium also uses intersatellite links for transmitting long-distance phone calls.

NOTE: In addition to subscriber costs, consumers will pay an additional existing terrestrial service charge when transmitting through those lines.

SOURCE: Office of Technology Assessment, 1993, based on information supplied in applications to the Federal Communications Commission.

Table 2-5—Big LEOS (Low-Earth Orbiting Satellite Systems)

| System | Holding company | Technology partners | cost |
|---|---|---|---|
| **Odyssey** | TRW, Inc. | N/A | $1.3 billion |
| Iridium | Iridium. Inc., subsidiary of Motorola Satellite Communications. Inc., subsidiary of Motorola. Inc. | McDonnell Douglas (launch vehicle);<br>General Electric Co. (ground stations):<br>Motorola, Inc. (electronics)<br>Raytheon (antennas)<br>Lockheed (satellites) | $3.37 billion |
| Ellipso | Ellipsat Corporation, subsidiary of Mobile Communications Holdings. Inc. | Fairchild Space & Defense Corp. (satellites and ground stations)<br>Israel Aircraft Industries | $410 million |
| Aries | Constellation Communications. Inc. | Defense Systems. Inc. (satellites):<br>MicroSat Launch Systems, Inc. (launch vehicle):<br>Pacific Communications Sciences, Inc. (system & software) | $294 million |
| Globalstar | Loral Qualcomm Satellite Services, Inc., subsidiary of Loral Aerospace Corp. & Qualcomm, Inc. (joint venture) | Loral Aerospace Corp. (space segment):<br>Qualcomm, Inc. (ground segment) | $748 million |

**Technology and Service Characteristics of Big LEOS**

| System | No. of satellites | Geographic coverage | Modulation | Handset cost | Service cost | Market estimates | Operational date |
|---|---|---|---|---|---|---|---|
| **Odyssey** | 12 | **North** America | CDMA | $1,000 | N/A | N/A | Mid-1 996 |
| Iridium | 66 | Global | TDMA/FDMA | $2,000-3,000 | $3.00 p/rein | 6 million | 1998 |
| Ellipso | 24 | U.S. & Territories | CDMA | $300 (add-on)[a]<br>$1,000 (new unit) | $0.60 p/rein | 18 million | Mid-1994 |
| Aries | 48 | Global | TDMA/CDMA/FDMA | $1,500 | N/A | 2.9 million | 1996 |
| Global star | 24 (first generation)<br>48 (second generation) | U.S. (first generation)<br>Global (second generation) | CDMA | *$700* (dual-mode)<br>$600 (single-mode) | $0.30 p/rein | 3,4 million | 1997 |

[a]Add-on to existing cellular handset.

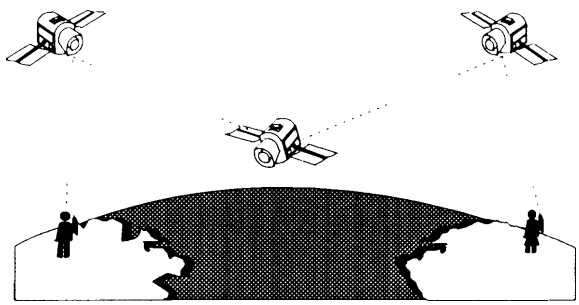
KEY: CDMA= code division multiple access, FDMA=frequency division multiple access, TDMA=time division multiple access

SOURCE: Office of Technology Assessment, 1993, based on information provided in system applications to the FCC,

**Figure 2-10-Satellite-Linked Mobile Phones: Two Approaches**

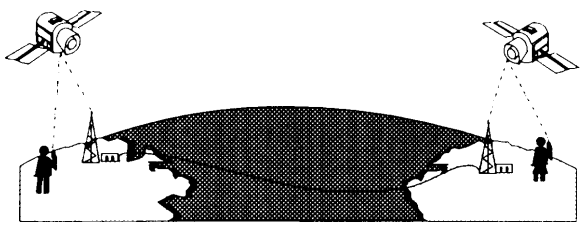
**Motorola's Original Iridium Plan**

A fleet of sophisticated satellites in low-Earth orbit pick up mobile phone calls from anywhere on Earth and could relay them from satellite to satellite, bypassing long-distance companies. Motorola has had difficulty developing a satellite with all the technical capabilities needed that could be launched at a practical cost.



Competing Satellite Plans

The satellites' only role is to link mobile phones to regional ground stations. Calls are switched and routed between ground stations over long-distance phone lines. Far fewer satellites are needed, especially if unpopulated areas and oceans are not covered, and the satellites can be much simpler in design.



**SOURCE: Office of Technology Assessment, 1993, based on Motorola, Loral, from *The New York Times,* Aug. 26, 1992, p. D5.**

In addition to the differences in basic concept, the Iridium system, which has been the focus-—fairly or unfairly-of most of the press attention to LEOS, differs in several respects from the other big LEOS systems. First, it plans to use many more satellites. The original Iridium concept called for 77 satellites, but in August 1992, that number was reduced to 66 as a result of improvements in satellite design. Second, Iridium plans to use time division multiple access (TDMA), a transmission technique that Motorola began developing for future digital cellular telephone systems, while the other four applicants plan to use code division multiple access (CDMA). Third, the *original* concept for Iridium envisioned a system that would not use the local telephone system or existing cellular networks. Rather, it would have bypassed terrestrial systems completely unless the number being called was a regular wired telephone (see figure 2-10). As noted, Motorola retreated from this bypass-oriented design in the face of harsh criticism from foreign governments and telephone companies, and is now developing a dual-mode mobile telephone. Finally, Iridium requires extremely sophisticated satellites that can route calls much like the switching centers used for public telephone service-making them substantially larger and costlier than the satellites of the other applicants. Because of the complexity and cost of the system, Iridium's usage charges are expected to be much higher per minute than its competitors ($3.00/minute as opposed to approximately $0.50, minute). Motorola points out, however, that users of the other big LEOS systems will have to pay long distance telephone rates in addition to the charge for using the satellite service, making the total cost of a phone call comparable.

In addition to the companies profiled in box 2-F, several other firms are planning or would like to use the big LEOS spectrum. AMSC, for example, has applied at the FCC to use the frequencies to support its geostationary system. Inmarsat has announced plans for Project 21, a global satellite telecommunications service that would provide mobile services to users at sea, in the air, and on land. Project21 has not been given final approval, but Inmarsat is conducting technical and marketing studies, and has already begun working with equipment manufacturers to de-

velop specifications for its handheld phones.[128] Inmarsat predicts the market for satellite phones will reach 2 million by the end of the century, but also believes that in order to be successful, these (types of) services must serve domestic users—international travelers are not a large enough market to justify the systems. A final decision of whether to proceed is expected in July 1993, and tentative plans call for the system to begin offering services by 1998. In anticipation of moving ahead with the project, Inmarsat has filed to use the frequencies allocated at WARC-92 for MSS.[129]

Finally, Celsat, Inc. proposed to build and operate a ''Hybrid Personal Communications Network" called Celstar that would operate in either L- or S-band.[130] Celstar would combine terrestrial and space technologies into a "super' cellular system that would use two geostationary satellites and many ground stations to supply voice, data, compressed video, and position determination services to as many as 750,000 users at a cost of $0.25/minute (for telephone service). Costs for satellite construction and launch are estimated at $660 million, while lightweight user handsets will cost $500.[131] Plans call for the terrestrial portion of the system to begin operating by 1993, with the satellites coming into operation in 1996. Celsat's petition to use the L-band frequencies for its system was denied by the FCC in August 1992.

In order to speed the development of service rules and technical parameters for big LEOS systems and services, the FCC in August 1992 asked for comments regarding the formation of an advisory committee to develop draft proposals for FCC consideration.[132] This process was first used to help the FCC develop the rules arid specifications guiding the development and operation of little LEOS systems (see appendix E). The big LEOS committee began its work in January 1993, and finished in April 1993. The final report of the committee will be submitted to the FCC for consideration as it writes a formal NPRM, which is expected to be released in May 1993. After the



Magellan Systems Corp.

*The U.S. Global Positioning System uses a network of satellites that allows users (in aircraft, on ships, or in vehicles) to determine their location almost anywhere on Earth.*

128 Like the phones proposed by the U.S. big LEOS applicants, Inmarsat's handsets (Inmarsat-P terminals) will be dual-mode. They are expected to cost around $1500.

129 The specific frequencies are: 1616- 1626.5 MHZ, 2483.5 -25(N MHz, and 1980-2010 MHz, all of which could b, 'Seal b, both geosynchronous and LEO satellite systems. See also, Ellen Messmer, ''INMARSAT Ready to Challenge Iridium,'' *Network World*, Mar. 16, 1992, p. 21; ''INMARSAT Files for Frequencies Following WARC, *Telcom Highlights International*, March 25, 1992, p. 17.

130 Celsat has filed an application at the FCC for reallocation of these frequencies, but no application for authority to construct the system has yet been filed. See Celsat, Inc., *In the Matter of Amendment of Part 25 of the Commission's Rules for an Allocation of Frequencies and Other Rules for a New Nationwide Hybrid Space/Ground Cellular Network for Person al/Mobile Communications Services: Petition for Rulemaking*, before the Federal Communications Commission, RM No. 7927.

131 Renee Saunders, ''Celsat Joins Mobile Satellite Contenders, " *Space News*, Feb. 17-23, 1992, p. 4.

132 Federal Communications Commission, "FCC Asks for Comments Regarding the Establishment of an Advisory Committee to Negotiate Proposed Regulations, ' CC Docket No. 92-166, released Aug. 7, 1992.

NPRM process is completed, the FCC hopes that the process of licensing providers of big LEOS service can be completed quickly.

As of April 1993, the big LEOS companies were in the process of completing design plans, building strategic and manufacturing partnerships, trying to convince foreign governments of the value of big LEOS, and searching out potential technology partners.

WARC-92 Negotiations-Big LEOS was one of the most difficult and complex issues debated at WARC-92. In broad terms, the debate pitted the United States and its allies against the Europeans and their supporters. U.S. support for the big LEOS concept was very strong and obtaining frequency allocations for these new systems was the highest U.S. priority at WARC-92. Many countries supported the U.S. position, especially developing countries who had become convinced of the potential benefits such systems could provide.

Before WARC-92 opened, U.S. and CEPT positions on MSS and big LEOS hardened, and preconference negotiations were unproductive. At the conference, negotiations continued to be difficult.[133] Both sides tried to find ways to tradeoff support for each others' systems, but such compromise was hard to achieve. A deal was struck only in the last hours of the conference.

Complicating the U.S. negotiating position on big LEOS was the support the United States had given to the Global Navigation Satellite System (GNSS) concept. GNSS is an international satellite system concept now being developed to provide global navigation services to aircraft, and that is designed to replace a confusing patchwork of different terrestrially-based systems around the world. The United States, along with ICAO and the former USSR, has been actively involved in the development of this concept since the rnid-1980s. Proponents expect that GNSS will use two satellite systems, the U.S. Global Positioning System (GPS) and the Russian GLONASS system (see box 2-E) to provide precise position determination and other navigation information to aircraft flying anywhere in the world.[134] The system is expected to increase safety, e.g., preventing disasters such as the downing of a Korean airliner over Russian airspace in 1983, and efficiency, by allowing planes to be spaced closer together on routes and allowing them to fly the most fuel/time efficient routes.

U.S. support for GNSS/GLONASS dates back to 1987. At the 1987 Mobile Services WARC, the U.S. opposed an L-band allocation for Aeronautical Public Correspondence (APC—see below) because it thought such use would interfere with the U.S. GPS and thereby threaten the operation of GNSS. At WARC-92, however, the United States not only supported, but proposed, frequency allocations for big LEOS that would use some of the same frequencies as GLONASS. This policy switch seriously underrnined U.S. support of the GNSS system in international eyes, and led many frustrated domestic and international aviation officials to question why the United States

133 EC observers, for example, believing that the CEPT countries had given up too much on little LEOS, pushed CEPT to take a hard position on big LEOS allocations.

134 Also being discussed is a potential European satellite aeronautical navigation system. European officials have reportedly shown some reluctance to use either the U.S. DoD-controlled GPS system or the Russian (Ministry of Defense's) GLONASS system. "International Air Traffic Control May Go From Radar to GPS,' *Telcom Highlights International,* vol. 14, No. 23, June 3, 1992. p. 17.

was willing to jeopardize years of work on GNSS.[135] Big LEOS proponents, on the other hand, believe that it is possible for both services to share the band, and that the U.S. positions were not mutually exclusive.

Some analysts and delegates believe that U.S. support for commercial big LEOS systems over GLONASS/GNSS at WARC-92 not only damaged U.S. integrity internationally-making it harder to "sell' U.S. positions at future conferences-but may also have set a bad precedent for future conferences. ITU members may try to reallocate frequencies used by the U.S. GPS system.

## ISSUES AND IMPLICATIONS

LEOS promise universal communications anywhere in the world, Brochures touting these services and the popular press extol the benefits to the world community and the technical marvels they represent. Such systems are also expected to generate huge revenues for services providers and equipment makers-estimates easily reach into the billions of dollars per year. At present, U.S. companies lead the world in the development of LEOS technology. However, a number of hurdles remain to be overcome before these services can be made available to the citizens of the United States and the world.

International Allocations and Licensing—Inter-nationally, the biggest potential problem facing the providers of big LEOS services is that they must obtain licenses in every country in which they plan to operate. Although international allocations for MSS/big LEOS were agreed to at WARC-92, those allocations must now be adopted by individual ITU member countries before the new systems can begin operations. Furthermore, there is no guarantee--even if the international allocations are adopted—that foreign countries will license all or even any of the U.S. companies that have proposed big LEOS services.

The possible implications of U.S. big LEOS proposals began to draw the attention of foreign telecommunications regulators and policymakers even before the end of WARC-92. European Community officials fear that the U.S. licensing process "ultimately will become a worldwide mandate, '[136] and that U.S.-operated systems will dominate this emerging market-precluding the introduction of (non-U. S.) competing systems.[137] At the conference, the EC Commission delivered a letter to Ambassador Baran, head of the U.S. delegation, requesting talks on the subject after WARC-92 ended. Informal talks were held in late summer of 1992, but no formal agreements were reached and no actions were taken as a result of the meeting. Among the issues discussed: licensing procedures in the United States and Europe, shared use of spectrum by existing and future systems, and domestic procedures for interconnecting satellite networks with the domestic

---

135 In the domestic preparation process, U.S. aviation interests opposed MSS/big LEOS allocations that they believed would threaten GLONASS/GNSS. They were not successful in having their views accepted, but they received assurances about protecting GLONASS in the FCC's final Report. The Report stated: "the Commission has been unable to determine the extent of [GLONASS] operations above 1610 MHz. Therefore, we have not been able to assess the potential for interference to GLONASS in the 1610-1626.5 MHz range. However, if it is determined that GLONASS is operating extensively above 1610 MHz, the U.S. Delegation will have the flexibility to modify the U.S. proposal to protect GLONASS."

The real meaning of those assurances in practice, however, became clouded at WARC-92. It became clear that GLONASS will operate above 1610 MHz, and the delegation did negotiate some protections for the system relating to allowable power levels, However, such protection was inadequate in the view of the domestic aviation community, who continue to feel that the United States was not truly committed to protecting GLONASS at the expense of the commercial big LEOS systems. See Federal Communications Commission "An Inquiry Relating to Preparation for the International Telecommunication Union World Administrative Radio Conference for Dealing With Frequency Allocations in Certain Parts of the Spectrum," *Report*, Gen Docket 89-554,6 FCC Rcd 3900 (1991), p. 15.

136 Daniel Marcus, "EC Fears Prompt Satellite Talks," *Space News*, vol. 3, No. 20, May 25-31, 1992, p. 1.

137 The licensing of big LEOS is unique in the history of international telecommunications because, although licenses will be granted by the FCC (a U.S. regulatory agency), the services these systems will offer will be global in scope-seemingly putting the FCC in the position of granting *de facto* international licenses.

telephone system in each country. Despite these talks, the Europeans generally remain cool to American big LEOS systems.[138] Consequently, the big LEOS providers are engaged in extensive efforts to persuade foreign spectrum managers that their systems pose no threat to established services. Ultimately, the survival of big LEOS systems will depend on how successfully they can lobby foreign governments.

If some countries decide not to allocate the spectrum agreed to at WARC-92, or not to license big LEOS systems—in order to protect existing systems, for example--it could seriously jeopardize the viability of the systems. Big LEOS companies could be faced with a patchwork service in which some countries would have service and others would not. The customer base and coverage of the system would be reduced, and the operator of the system would have to find some way to actually turn the system off over offended countries. While it is technically feasible to do this, software solutions will be extremely complex and expensive. In addition, differing amounts of spectrum are allocated in different countries, and adequate frequencies might not exist in some cases for multiple systems. Such scenarios may make operating a true global system technically unrealistic.

Frequency Coordination **and Sharing—** Spectrum sharing and coordination in the big LEOS frequencies is expected to be even more difficult than the problems faced by little LEOS. Because of the limited amount of spectrum allocated to LEOS at WARC-92 and the bandwidth requirements of the systems themselves, only a limited number of such systems can be accommodated worldwide, a fact recognized by the delegates to WARC-92 in Resolution 70.[139] This recognition also led the conference to adopt Resolution 46, which defines interim coordination procedures for LEOS and calls for future study by the CCIR.

Domestic *Coordination:* Frequency sharing and coordination problems faced by big LEOS services split along two dimensions. First, the five big LEOS proponents must find ways to share the allocated spectrum amongst themselves. Given the relatively small amount of spectrum allocated, and the relatively large (compared with little LEOS) bandwidth requirements of voice services, this could prove to be a substantial challenge. Complicating this problem, the big LEOS companies have proposed different transmission modulation schemes. Iridium, as noted above, plans to use TDMA, which Motorola is also developing for digital terrestrial cellular services. The other four applicants have proposed to use CDMA to provide their services. Because these two forms of modulation are different, they cannot use the same frequencies. The negotiated rulemaking proceeding at the FCC attempted to work out a compromise on this issue, but discussions were not successful. Ultimately, the FCC will have to decide how best to accommodate the needs of all the applicants. Unless one side or the other relents, it must find some way to allow both CDMA and TDMA transmissions to be used.

A number of commenters have pointed out that the ability of the four CDMA systems to share amongst themselves may also be limited. Limitations on power and hence capacity, according to one commenter, are ''certain only to increase the effective cost per circuit for each system, increase the ultimate price to the end user, and possibly jeopardize the viability of one or more of the competing applicants. ' '[140] Perhaps for this reason, some analysts have suggested that a consortium, like AMSC, may be one alternative to providing big LEOS services.

In addition, any future big LEOS system will have to share the bands with the services already

---

138 ''Satel Conseil Examines WARC Results, Especially LEOS,' *Mobile Satellite Reports, vol. 6, No. 21,* Oct. **12, 1992.**

139 ITU, *Final Acts,* op cit. foomote 27, p. 117.

140 Celsat, op. cit., footnote 130, p. 46.

using the frequencies. Observers have pointed out that sharing with existing services may be possible or more easy to negotiate if the other services are willing to compromise and work with the U.S. big LEOS providers. If such cooperation is not forthcoming, and if their consent to share the bands is not obtained, many believe that, as currently designed, big LEOS will not be able to share spectrum in the short term.[141] Over the next several years, as technology is developed to work around such constraints, big LEOS could come into operation, but they would be years late and equipment would likely be much more expensive than originally planned. Either one of these possibilities could conceivably derail these systems.

For example, the bidirectional use of the 1613.8 -1626.5 MHz frequency band by Iridium may cause serious sharing problems. As noted above, the downlinks that Motorola plans to use for Iridium were granted only secondary allocations at WARC-92. The CCIR has tentatively recommended that systems using these frequencies should not cause interference to systems operating on a primary basis. ''The recommendation would prevent Iridium-which will have a secondary downlink at 1613.8-1626.5—from interfering with other primary and secondary users in the band. [142] This fact, combined with the high power levels characterizing Iridium's TDMA system, ''virtually precludes the possibility of Iridium sharing spectrum with any other satellite system—U.S, or foreign. ''143 The CCLR called for additional studies to examine the problems.

*GLONASS:* The most difficult international frequency coordination problem will be with the Russian GLONASS system.[144] Although both types of proposed big LEOS systems may interfere with GLONASS, Iridium appears to present more severe and difficult sharing problems because of the concentrated signal power of Iridium's TDMA modulation scheme. Motorola has said that it cannot share with GLONASS and will seek to operate in frequencies not used by the system. ''MSS industry observers saw the limits imposed on the big LEO allocations as favoring the four applicants who proposed to operate in separate uplink and downlink bands, while raising potential problems for the Iridium system. [145] The four CDMA companies believe that they can share with GLONASS, but there is concern that with all four systems functioning, interference might become a problem. Theoretically, the CDMA systems could use the entire 1610-1626.5 MHz band, while Iridium, which plans to use TDMA bidirectionally can only use that portion of the band not used by GLONASS.[146]

One specific potential problem is the operation of the user terminals in the uplink allocation at 1610- 1626.5 MHz. Interference from these portable telephones could be just as serious as interference from the satellites, and could make coordination of big LEOS systems difficult since the primary status of the existing services gives them advantages in negotiations. GLONASS receivers, for example, which are to be mounted on the top of the aircraft, are very sensitive. Although the

141 The basis of this belief is the extremely restrictive power levels (power flux density (PFD) limits) that have been placed on LEOS operations. While current proponents claim that they can share the spectrum, other analysts believe that more sophisticated and expensive equipment-now just being designed-will be necessary.

142 ''CCIR Sees Problems With Bi-directional Operation of Iridium,'' *Satellite* News, vol.16, No. 5, Feb. 1, 1993, p. 4.

143 Ibid.

144 Because the U.S. GPS system uses frequencies in a lower frequency band (1565.1585 MHz), it will not be affected by the big LEOS systems.

145 ''U.S. 'Big, Little LEOs' Get Allocations at WARC. . .,'' *Telecommunications Reports, Mar. 9, 1992,* p. 14.

146 What frequencies GLONASS will actually be using when fully operational is still not clear. Shortly before WARC-92, the Russians filed plans at the ITU to use frequencies up to 1620 MHz, thus leaving Motorola with only 6.5 MHz in which to operate. It is unclear if Iridium could operate (with adequate quality and capacity) with this limited amount of spectrum.

receivers would be partially shielded from interference from mobile telephones by the body of the plane, when the aircraft is turning and banking (especially during landing and takeoff), the GLONASS receiver could be exposed to interference from nearby user terminals.[147] In order to limit interference from the handsets and protect the existing services in the band, WARC-92 (footnote 731X) put restrictions on the transmission power from user terminals. Design and implementation of big LEOS systems under these constraints will be technically challenging, but should be possible.

Implementation of big LEOS systems will face two critical issues vis-a-vis GLONASS. First, some arrangement must be worked out with GLONASS officials to insure that U.S. big LEOS will be able to operate effectively across the entire frequency band allocated at WARC-92. Motorola officials have said that they cannot share with GLONASS or GLONASS-M (an expanded version of GLONASS). This prompted the United States to oppose attempts to implement GLONASS-M. Alternatively, the frequency allocations and assignments made by the FCC will have to work around the GLONASS system, Second, the United States would have to oppose more stringent power limits than those defined in footnote 73 1X. Because no LEOS systems are operating, it is difficult to judge the real effects of any potential interference they may cause to existing systems. In practice, it is possible that the limits on big LEOS power set out by WARC-92 are not strict enough—the U.S. delegation was successful in negotiating limits that were at least workable in the interim. In that case, the members of the ITU may decide to make the limits more stringent. However, if the power limits are made much stricter, big LEOS proponents believe that their systems may not be able to operate.

Continued U.S. Government support of the big LEOS concept puts it in a difficult position regarding the use of the L-band frequencies, The United States now supports two systems/users competing for the same frequencies: GLONASS, which is viewed by the Federal Aviation Administration (FAA) as an integral part of the future global navigation system, and big LEOS. At least two related consequences of the U.S. actions at WARC-92 must be considered. First, what, if any, backlash could be taken against the U.S. GPS system at future international meetings? Second, from a broader perspective, what effect will big LEOS systems really have on GLONASS, and was promoting big LEOS a sufficient reason to risk the future of the GNSS system?

This issue highlights the policymaking gap that exists in U.S. international radiocommunications policymaking. In this case, powerful commercial interests with little more than a conceptual plan and initial technical designs were able to undermine an established, U.S. Government (FAA)-sanctioned, civil aviation initiative that is already partially finalized globally and is already operating. No public proceeding assessing the advantages of one versus the other was held, and no accountability for the policy shift has been assigned. The mechanism by which this decision/shift was made is invisible, and the reasons so far undocumented.[148]

*Radio Astronomy:* Another potentially difficult sharing problem will have to be worked out between the big LEOS providers and the world's radio astronomers. Radio astronomy is now allocated on a primary basis in the 1610.6- 1613.8 MHz band, and is protected from interference by two newly modified footnotes (733E and 734). Footnote 733E specifically protects radio astronomy operations from interference from MSS (including LEOS) systems. Since radio astronomy

147 In interpreting data on interference and sharing, therefore. it is important that these problems be taken into account and that computer models do not assume an aircraft flying level.

148 Although such conflicting policy decisions are normally worked out in discussions within the Interdepartment Radio Advisory Committee and between NTIA and the FCC, it is not clear to what extent NTIA was aware of the implications of FAA's support of the GLONASS system.

uses extremely sensitive receivers and requires precise measurements, almost any interference caused to radio astronomy services could be serious. Big LEOS proponents believe that the position determination capabilities of their systems will be sufficient to protect radio astronomy applications.[149] The radio astronomy community generally does not share that confidence.

The real issue in this case, however, maybe the political support enjoyed by each side. Radio astronomers do not have the economic clout of private sector industries, and hence their political leverage is limited. In cases where interference is a problem, it is possible that the complaints of radio astronomers will be accorded less importance than the concerns of commercial ventures.

**Market Considerations-Aside from the technical** and regulatory questions plaguing the development of big LEOS, a more fundamental problem has not been adequately addressed. What is the market for these types of services? Will big LEOS services be profitable in the long term? A number of assumptions underlie predictions about big LEOS services that have not been adequately analyzed. These assumptions need to be examined in order to assess the market potential for big LEOS services and the viability of such services in the long term.

The question of potential market size for satellite telephony must be put into context—users do not care how their service is delivered, whether by satellite (LEOS or geosynchronous), cellular, or emerging personal communication services. Thus, the critical questions are: What is the market for mobile services? What other technologies will compete? What portion of the overall market can LEOS services realistically expect to capture? Inmarsat, for one, estimates the worldwide market for satellite mobile phones will reach 2 million by the year 2000.[150] Early estimates put the dollar value of mobile satellite services (including both large and small LEOS) at $1 billion by 1995 rising to $9 billion by 2000.[151] However, cutting through the hype of promotional brochures and presentations on big LEOS services to realistically assess expectations is difficult. And while initial projections made by the companies in their original applications would lead one to believe big LEOS will be serving millions of users in a few years, a number of doubts remain, and most analysts question the market analyses done so far. An examination of the marketing projections filed with the companies' initial applications reveal a wide range of market estimates for essentially the same service.

In an ironic twist, the big LEOS proponents themselves may have limited their potential revenues by promoting a dual-mode approach. In systems with dual-mode designs, the user's portable phone will first search the airwaves for a local cellular service, and if no such service is found, the system would then automatically switch to the satellite system. The problem is that if the phone finds the local system, as it will most of the time in the United States, Europe, and many other developed (and some developing) nations, the satellite system will not be used, and no revenues will be generated.

A dual-mode approach (using U.S. handsets) could also draw the ire of foreign cellular carriers who may operate on different frequencies than the United States. When the dual-mode phone attempts to connect to a cellular system in a foreign country, it may not be capable of operating on the

---

l@ Since radio astronomy facilities are usually located in remote parts of the world, interference from user terminal s is expected to be minimal. Some proponents have suggested that since radio astronomy receivers are located at well-known positions, the big LEOS systems could use the position determination capability built into their systems to actually turn off user terminals that get too close to such facilities. Signals from the satellites, however, represent a much more serious problem as they cannot avoid a particular area.

150 ''Inmarsat Satellite Telephone Venture Launched, '' *Telcom Highlights International*, vol. 14, No. 43, Oct. 28, 1992.

151 Data here was reported in ''Mobile Satellite Communications Market to Pass $1 Billion in 1995, ' *Telcom Highlights International*, Feb. 6, 1991. Study was conducted by International Resource Development, Inc., and based on the expectation that services would start in 1994 or earlier,

local frequencies, and would switch to the satellite system, bypassing the local cellular carrier. Many types of dual-mode phones may have to be produced to work in various countries-defeating one of the purposes of ubiquitous worldwide coverage.

A similar problem that may decrease the potential markets for the dual-mode satellite services is the potentially divided nature of the future installed base of cellular users. Depending on which service consumers use, they may be served by either a CDMA or TDMA cellular system. This prior use may constrain which satellite system a user can subscribe to--TDMA users would have to use Iridium (and only Iridium) while CDMA users could choose between the other four (if they all survive), but could not use Iridium. In order to promote maximum flexibility, users might have to use a tri-mode phone, which is not (yet) being developed.

Thus, the big LEOS service providers could be limited to marketing essentially to areas without cellular service. Current populations may not be able to support deployment and continuing operation of a $1 to $4 billion LEOS system. Basing expensive systems on speculative projections seems optimistic at best, and an invitation to financial disaster at worst. Compounding the problem is that there is not one, but potentially six companies vying to offer these services. Clearly not all are viable or will survive.

*International Markets;* A significant part of the justification for big LEOS services is their ability to serve the communication needs of countries with underdeveloped terrestrial communications systems. This marketing pitch was used to great advantage at WARC-92 to build support among the developing countries. However, some observers question whether such benefits will actually flow to those countries.[152] These countries (and their citizens) do not have substantial financial resources and the big LEOS equipment and services are expected to be very expensive initially. Motorola's Iridium phone, for example, is expected to cost $3,000 when introduced, falling to about $1,500 when mass produced. In the United States, the average consumer is relatively affluent, with an average per capita income (1988 dollars) of $16,444.[153] For much of the rest of the world, however, consumers are not so well off. The per capita income in the Central African Republic, for example, is approximately $376, meaning that the average consumer would have to work 4 years to buy a phone. Even if national governments buy the phones, who will pay for the services? At $3.00/minute it would take 17 hours of labor just to make a 1 minute phone call! 154 In any case, these numbers are not well quantified, and require more analysis before foreign market potential can be realistically estimated. [155]

Basing projected subscribership and/or revenues on international travelers is also risky. Such travelers are likely to stay in major cities where they will have access to local wired infrastructure as well as local cellular providers (assuming they have a dual-mode phone capable of working in the country in which they are traveling)-further shrinking the potential market for satellite services. If they cannot use the local cellular provider, they would use the satellite system. However, local or national cellular providers in foreign

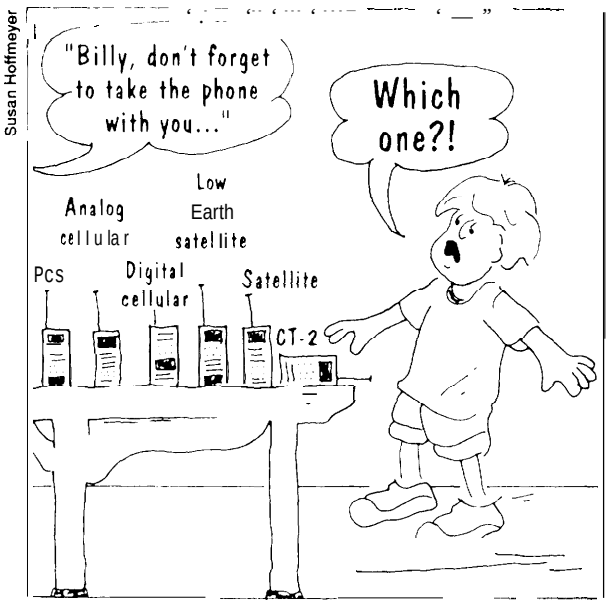
---

152 Some more cynical analysts believe that, in fact, the big LEOS providers have little interest in serving developing counties because they realize that profits will be slim at best. Instead, these analysts believe, the applicants will concentrate their development and marketing activities in the most industrialized countries. If anything, they believe, users in developed countries will end up subsidizing users in developing countries. From this perspective, advertising the benefits for developing countries is little more than good public relations and a way to win international support.

153 per capita income figures provided by Mark S. Hoffman (ed.), The *World Almanac and Book of Facts: 1992* (New York: Pharos Books, 1991).

154 Assuming that the average consumer in the Central African Republic works 40 hours a week, 52 weeks a year.

155 Some observers predict that recovering any significant revenues from the developing countries may take as long as 10 years.




countries will strongly object to this form of bypass, unless a revenue sharing plan is in place.

Finally, counting Europe and Japan as potential markets is risky for two reasons. First, both are already deploying terrestrial systems that would directly compete with big LEOS services. Second, licensing big LEOS services in Europe could be extremely difficult, as demonstrated by CEPT opposition to U.S. proposals at WARC-92, European countries have serious doubts about allowing mobile satellite services to share with their existing terrestrial (mobile) services, and will likely take steps to protect and promote their systems at the expense of, especially U. S., competing satellite-based systems.

Envisioning such global systems without European connections is even more difficult. Such systems may not be able to survive without access to European markets. Motorola, for example, has said that ''we do not see Iridium without European participation," and, consequently, is busy trying to convince European governments that Iridium poses no threat to their existing or planned systems, including FPLMTS.[156] Thus, talks between EC and U.S. radiocommunication officials are crucial to the success of U.S. big LEOS systems.

*Domestic Markets:* Leaving aside international markets, even marketing big LEOS services in the United States could be difficult. As noted above, mobile phone users will not care how their service is provided—by satellite, cellular, or PCS—and the mobile phone market may not be big enough to support many competing technologies and companies. Cellular telephony, for example, has a big head start in coverage and in signing up customers. Cellular telephone service is available to over 80 percent of the U.S. population, and covers approximately 60 percent of the country (excluding Alaska).[157] If big LEOS companies plan to draw customers away from cellular companies they may have a difficult time unless they can show that their service is of better quality, cheaper, or different than cellular. In the meantime, the cellular industry will move ahead with its own improvements. Coverage will improve as more rural cellular systems are built, roaming between cellular areas will become easier, and capacity and quality will improve as digital cellular systems are implemented.[158]

*Inmarsat: The* prospect of Inmarsat entering the market for mobile satellite services presents its own set of problems for U.S. regulators and policymakers. Originally, Iridium announced that it would like to sell satellite capacity to, partner with, or complement Inmarsat. Inmarsat, however, seems clearly focused on providing its own

156 Comments of Mike Pellon, quoted in Andrea.s Evagora, ''CEPT: Radio Interference,' *Communications Week International, July 20,1992,* p. *4.*

157 Elliot Hamilton, Economist, Economic Management Consultants, Inc., personal communication, July 29, 1992.

158 McCaw Cellular, for example, is in the process of building a nationwide cellular network through agreements with local cellular operators throughout the country.

system in competition with Iridium.[159] This poses a Policy dilemma for the U.S. Government: should it support Motorola and its $3+ billion system, or should it side with Inmarsat, in which the United States holds a major interest through its signatory, Comsat?

This increasingly bitter battle has reached the highest levels of the U.S. Government, Motorola points out, and others agree, that Inmarsat, which is a consortium primarily funded by government-owned and/or controlled 'signatories, ' could use its influence and current position as a supplier of mobile services worldwide, to politically block out new, private sector competitors.[160] Others believe that the potential entry of Inmarsat into the MSS business has stifled, and will continue to depress, investment in private satellite systems, as investors wait to see what Inmarsat will do. Even if U.S. systems do begin offering services before Inmarsat, they believe, Inmarsat may be able to arrange incentives such as tax breaks that would give it an unfair global advantage. This could ultimately result in a (worldwide) monopoly for Inmarsat and high prices and poor quality for consumers.[161] This is one reason some observers believe it is important to support AMSC—to provide competition to Inmarsat.

Currently, the FCC is pushing ahead with big LEOS licensing in order to help U.S. systems become operational quickly, an important consideration from a marketing perspective. Timely licensing of U.S. systems could provide them with an important competitive advantage to offset the global (political) support that Inmarsat could muster. This approach could also allow the United States to avoid having to support one side over the other. U.S. systems could come into operation first, and then the United States could support the entry of Inmarsat into the business as an enhancement to competition.

Technology Issues-In addition to the questions raised over frequency coordination and sharing, questions have been raised over some of the technical details of the individual systems.[162] This section will not analyze the technical feasibility of each system in detail since each proponent continues to refine their technical plans and make improvements in their original system design. Instead, it identities broad concerns about the technical details of the systems-issues that must be addressed by all proponents to develop a viable system.

One of the most serious concerns facing big LEOS operators is the limits WARC-92 placed on the power these systems can use. Because the systems are not yet operational, questions have been raised about the power requirements and whether the satellites will be able to deliver the power needed to effectively provide the proposed services.

Related to the question of power, one of the more difficult technical problems involves the ability of the systems to penetrate buildings.[163]

---

159 Patrick McDougal, Inmarsat director of strategic planning, said that 'they will be fighting for the same customers.' Quoted in 'Special Report— Satellite Competition Heating up in Europe, Asia, ' *Satellite News,* vol. 15, No, 11, Mar. 16, 1992, p. 7.

160 See, for example, a report prepared for Iridium, Inc. by Nathan Associates, Inc., ''Inmarsat's Project 21 and U.S. Policy," June 5, 1992.

161 Ibid.

162 Mitre Corporation, for example, completed an initial analysis of the technical feasibility of the various LEOS systems based on tick original applications at the FCC. The report notes numerous instances in which proponents' claims-about satellite coverage areas, weight, and system communications capabilities cannot be verified. However, the report also concludes that none of these technical issues seemed "insurmountable." Mitre does not expect any of the big LEOS systems to be operating before 2000. W.J. Ciesluk, L.M. Gaffney, and N.D. Hulkower, et al, ''An Evacuation of Selected Mobile Satellite Communications Systems and Their Environment, ' The Mitre Corp., Bedford, MA, April 1992.

163 Although engineers are divided on this problem, a number of issues that require further research remain to be resolved. One issue involved is where the testing should actually be conducted. Circular orbital paths converge as they approach the North and South Poles. This means that the satellites in those orbits will be closer together, meaning that a satellite is more likely to be closer to the user and more able to give a good signal. If testing is conducted in these areas, as opposed to around the equator, results will likely be too positive. Relying on tests conducted only in the United States or Europe will lead to false assumptions about service availability and quality in other parts of the world.

Unlike cellular telephony, which is terrestrially-based and has radio waves that travel along the ground, satellites, which will be flying high above the ground, may not have suitable angles for penetration into buildings. Because of the frequencies involved, a clear line-of-sight may be needed to the satellite, requiring users to either go outside or stand at a window. The problem is compounded by the nature of LEOS themselves; they are not stationary with respect to the Earth-the line-of-sight will change as the satellite passes through its orbit. Furthermore, as the satellites travel in their orbits toward the equator, they will spread out; i.e., some areas will be further from the satellite than those directly beneath its orbital path.[164] See figure 2-8, for example. In those far away cases, direct line-of-sight to the satellite may be a necessity for any communication. More testing is needed.

Yet another issue, although not strictly technical, is that of replacement satellites. The 5-year lifespan of the LEO satellites is relatively short compared with the 15-year lifespan of most geosynchronous satellites, That means that replacement satellites will have to be built and launched *continuously* as long as the system operates. The often-overlooked ongoing nature of these enterprises raises two major concerns. First, the costs of the systems as addressed in their applications are merely the initial costs of bringing the system into operation. The companies operating these systems will also incur substantial recurring costs of maintaining the system—building and launching new satellites.

Second, the ability of the system to operate continuously will depend on a continuing supply of new satellites. If, for any reason, the satellites cannot be built, cannot be launched, or fail in orbit, the system's reliability and integrity will be jeopardized. Some analysts have suggested that to meet such launch requirements, a very high launch reliability will be necessary, a level that is presently above current averages. Given the nature of some of the (emergency) services expected to be provided by these systems, such a level of risk will require careful monitoring by government agencies to ensure continued system reliability and quality.

Iridium, because of its complexity, poses several unique technical questions. Some analysts cite a number of technical factors that lead them to believe that Iridium probably will not be viable in the near term. For example, Iridium's plans call for satellites to communicate not only with users and gateways on the ground, but to transfer calls between satellites. This additional feature increases the complexity and weight of the system, and introduces unique technical challenges for Motorola that do not concern the other proponents. First, the satellites are much more complex and difficult (and costly) to build-they will be essentially switching centers in the sky.[165] Second, the software to control the complex switching (intersatellite links) envisioned in Iridium is a major development challenge.

All the applicants for big LEOS systems will be retuning and improving their system and satellite designs until formal rules are adopted and licenses granted by the FCC. With the recent changes in its system design, Motorola officials hope to refocus attention on the promise of the system rather than its past troubles. Changes in the system do not necessarily indicate fundamental weaknesses in the technology as much as continual improvements in the system design.

As a result of the above concerns, investment financing for big LEOS companies has been very hard to generate.[166] The worldwide economic downturn, combined with the regulatory, technical, and market uncertainties associated with the

164 Because of its elliptical orbit, Ellipsat has a different set of concerns about the positioning Of its satellites.

165 The satellites of the other systems function essentially as a "bent Pipe' '--merely relaying signals that are sent from the ground. They will encompass few, if any, switching functions.

166< 'On the Trail of Investors: LEOs Face Financial World's Skeptics, *Satellite News*, vol. 15, No. 37, Sept. 14, 1992.

systems has reportedly made them a ''hard sell" to the world's financial community. Time will eventually bring an economic recovery, and time could be used to improve the systems and services, but time is also the enemy of emerging systems. Existing (cellular) systems are expanding their coverage and improving their services at a rapid rate, and other new mobile technologies are also waiting in the regulatory wings.

## OTHER U.S. ALLOCATION PROPOSALS TO WARC-92

### Broadcasting-Satellite Service-HDTV

#### BACKGROUND

High-definition television refers to the next generation of television service that will have high resolution (nearly twice that of conventional television), better color, a wider screen, and compact disc-quality digital sound. It has been under intensive development in the United States, Japan, and Europe for several years.[167] Originally, HDTV developers planned to use an analog transmission format similar to that used by today's television sets. However, the superior picture and sound quality of HDTV would require much more bandwidth (and spectrum) to transmit the HDTV signal. Because these analog HDTV signals were expected to occupy so much spectrum, they would not fit into the channels that had previously been defined and planned for satellite television broadcasting in the 11.7-12.75 GHz band. As a result, new international allocations for satellite-delivered HDTV were believed to be necessary. The 1988 WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (ORB-88) attempted to allocate frequencies for these new wide-band television services, but no agreement was reached and the debate was carried over to WARC-92.

A desire to promote the development of one worldwide HDTV standard was one of the original forces pushing a worldwide allocation for BSS-HDTV. As countries developed different systems, however, and made choices about how HDTV would be delivered, standards began to diverge. Thus, at WARC-92 the rationale for a worldwide allocation, while still powerful, had lost some of its urgency.

#### U.S. PROPOSAL

The U.S. proposal for BSS-HDTV had two main components. First, the United States proposed that the existing allocations and associated plans for satellite television broadcasting around 12 GHz could serve as the basis for worldwide HDTV allocations.[168] This proposal was based on the expectation, discussed below, that developments in digital compression would allow HDTV signals to fit into the existing allocation plans. However, in order to accommodate future growth of the service and specific HDTV station assignments that could not be made according to those

---

167 HDTV was originally conceived more *than 20 Years* ago, but only recently have advances in microelectronics and digital signal processing brought the technology close to commercial applications, For discussion of the historical, technical, and economic implications of HDTV, see U.S. Congress, Office of Technology Assessment, *The Big Picture: HDTV and High-Resolution Systems,* OTA-BP-CIT-64 (Washington, DC: U.S. Government Printing Office, June 1990).

168 In the early 1980s, a separate (from HDTV) trend was developing that would directly affect the U.S. WARC-92 proposal. With advances in satellite technology and the shrinking of consumer electronics, entrepreneurs began to develop satellite systems they hoped would bring many channels of television programming directly into consumers homes via small (18 inches) receiving dishes. These services were dubbed DBS—direct broadcast satellite. In order to accommodate these new satellite services, the countries in Region 2 (essentially the Western Hemisphere) agreed in 1983 to allocate frequencies (12.2 -12.7 GHz) and developed a plan to implement DBS services. These allocations were formally adopted by the ITU at the 1985 WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It (ORB-85), Geneva, 1985. This conference also allocated spectrum to satellite broadcasting services in 11,7 -12.5 GHz in Region 1 and 12.2-12.5 GHz in Region 3. Thus, no common worldwide allocation was achieved. Although no DBS systems are yet operating in this country (Europe has operating DBS systems), several companies continue to pursue the idea of delivering television programming by satellite (see below).

plans, the United States also proposed to allocate the 24.65-25.25 GHz band for use by HDTV satellite broadcasting.

### RESULTS

The U.S. proposals did not generate adequate support, and the United States eventually changed its position in order to support a common Region 2 allocation. In fact, WARC-92 delegates were unable to agree to a single worldwide allocation. Instead, the conference adopted two separate allocations, one (17.3 -17.8 GHz) for Region 2, including the United States, and another (21.4-22.0 GHz) for the rest of the world. These allocations cannot come into effect until April 1, 2007. In addition to the allocations for BSS-HDTV, allocations were made for frequencies to support BSS-HDTV systems. [169] WARC-92 also adopted Resolution 524, which calls for a future conference to consider modernizing the existing satellite broadcasting plans (originally set out in 1977) for Regions 1 and 3 in order to better accommodate digital HDTV technology.

### DISCUSSION

HDTV was not one of the highest-priority concerns for the United States at WARC-92. In fact, the U.S. proposal for using the 12 GHz bands for HDTV was less a proposal than a position—it required no new allocations or regulatory changes.' 70

Several factors underlie the U.S. position. First, there is little tradition of satellite delivery of television programming in the United States. Despite the 3 million backyard satellite dishes owned by American consumers, direct broadcasting by satellite (DBS) has not yet taken hold in this country. There are currently no DBS services in the United States, and the first is not expected to be operational until late 1993. Europe and Japan, by contrast, have operated DBS services in their countries for several years, and see HDTV as a natural extension to those systems. Japan, in addition, has been operating a satellite HDTV channel on a limited basis for several years. In the United States, by contrast, the primary focus for HDTV delivery has been on terrestrial broadcasting solutions—in large part a response to the historical importance and power of American broadcasters. [171] In addition, the U.S. position was based on the belief in this country that advances in digital signal processing would allow HDTV signals to be transmitted in the narrow channels that had previously been defined in the 12 GHz plans, thereby eliminating the need for extensive new allocations. This belief, in turn, was based on the continuing development of digital HDTV systems in the United States. [172] U.S. engineers expect these systems, which take advantage of advanced compression techniques, to be able to transmit full HDTV-quality programming in the 24 MHz television channels that are now used for conventional television broadcasting.

Engineers in other countries and the CCIR report on the technical bases for WARC-92 were less optimistic about the prospects of digital compression and of fitting all HDTV channels into existing plans, and the United States had a difficult time convincing other countries that such technologies could actually produce the high level of quality they believe HDTV viewers will

169 These ''feeder link'' operations were allocated frequencies at 18.1 -18.4 GHz (footnote 870A), 24.75-25.25 GHz (the original U.S. proposal for BSS-HDTV, footnote 882Z), and 27.5-30.0 GHz (footnote 882 W).

170 Tacit recognition and acceptance were given t. use of the existing plans in Resolution 524, in which WARC-92 delegates called for a reworking of existing plans in Regions 1 and 3 to better utilize modern HDTV technology.

171 This is an oversimplification. The delivery of HDTV signals t. the home consumer has been an intense struggle between local broadcasters, cable companies, and DBS service proponents. Each is actively testing HDTV transmission systems, and the FCC *is* expected *to* define a standard for HDTV sometime in 1994.

172 Originally, all of the proposals for U.S. systems were analog. The Conversion to digital began with the announcement by General Instruments that they would develop an all-digital HDTV system. All the other remaining proponents quickly followed suit, with the exception of Japan's Muse system, which eventually withdrew its system from consideration.

demand.[173] As a result, the primary focus of the HDTV debate at WARC-92 centered on where to put the additional bands that countries perceived would be needed for HDTV service.

There were initially three proposals for new HDTV frequencies. The United States, supported initially by Japan, proposed to allocate the 24,65-25.25 GHz band to BSS-HDTV. Many of the countries in Region 2 supported an allocation at 17.3 -17.8 GHz, and CEPT, supported by Australia and the Russian Federation, proposed an allocation at 21.4 -22.0 GHz.

Each of the various proposals had specific advantages and drawbacks. The U.S. proposal was unsuccessful largely because other countries believed that the extremely high frequencies proposed by the United States would take more power to deliver and consequently systems would cost more to build and operate.[174] Despite U.S. technical papers showing that the costs of these systems would not be substantially higher than those that would operate in the other proposed bands, by the third week of the conference, the U.S. position had garnered little support internationally, and U.S. delegation leaders decided to pursue an alliance with other Region 2 countries, who advocated BSS-HDTV allocations in the 17.3 -17.8 GHz band. The 17.3 -17.8 GHz proposal suffered primarily from its impacts on existing services and on plans to use the band in support of other services in Regions 1 and 3. The 21.4-22.0 GHz proposal, by contrast, enjoyed substantial international support-CEPT was able to line up as many as 55 countries to support its proposal-but was unacceptable to the United States because those frequencies are used in this country for microwave telephone links. U.S. and other delegates from Region 2 were successful in preventing the 21.4-22.0 GHz band from being allocated to BSS-HDTV in the region. If that had happened, many U.S. microwave communication users would have been forced to relocate to other bands, costing the industry a great deal of money and causing disruptions in domestic point-to-point communications.

### ISSUES AND IMPLICATIONS

WARC-92 established relatively long lead times (the year 2007) before BSS-HDTV could be implemented in order to allow existing users of the band adequate time to shift their operations to other bands, but perhaps more importantly to allow the technology to more fully develop. A long lead time will allow standards to be developed for HDTV transmission around the world, and will allow engineers and spectrum managers to become more familiar with the operational characteristics of satellite HDTV systems only now being designed. Long lead times are not expected to constrain new HDTV services, since existing BSS bands will likely be used at frost, and it will be some time before demand for HDTV will require the additional spectrum.

Satellite-delivered HDTV services in the United States are expected, at least initially, to be provided using the frequencies outlined in the existing 12 GHz plans for DBS. As a result, the future of satellite HDTV is closely tied to the relative success or failure of current DBS efforts. If the systems now being planned to deliver (standard analog) television programming directly to home consumers from satellites do not come to fruition, or if the services fail to attract a sufficient number of subscribers, future plans to deliver HDTV programming by satellite may be reevaluated.

---

173 International Telecommunication Union, International Radio Consultative Committee, *CCIR* Report: *Technical and Operational Bases for the World Administrative Radio Conference 1992 (WARC-92)*, March 1991, p. 7-1.

174 Interestingly, some of the European countries reportedly had originally wanted to propose these same frequencies. However, because of a compromise agreed to in the CEPT, they decided to support allocations in the 21.4-22.0 GHz band instead. So, despite sympathy for the U.S. position, CEPT unity prevailed on this issue.

On the other hand, if DBS services "take off," the delivery of HDTV by satellite becomes much more likely. Hughes Communications' DBS system, DirecTv, for example, is moving ahead with its plans to deliver television direct to homes.[175] The system is expected to begin delivery by early 1994, and will use two satellites to carry up to 150 channels of programming on 32 transponders.[176] Its first satellite is scheduled to launch in December 1993, and co-owner United States Satellite Broadcasting (Hubbard Broadcasting) has already purchased 5 of the satellite's 16 transponders, with 5 more dedicated to cable programming for rural areas. The remaining 6 transponders will be used by Hughes for DirecTv entertainment programming.[177] Depending on the success of these services, other providers may decide to enter the DBS/HDTV arena.[178] If DBS and initial HDTV services are successful, it is likely that the additional frequencies allocated by WARC-92 for BSS-HDTV will be used to accommodate (new) providers that cannot be accommodated in the lower bands.[179]

However, even if DBS does not succeed and direct-to-home HDTV satellite services never come into operation, viewers may still have the opportunity to get such services. Satellites will continue to carry video traffic for the major broadcast and cable networks, and consumers who wish to purchase their own ''backyard dishes" (and any descramblers needed) will be able to receive HDTV services just as they receive television service today.

It is too soon to tell how successful DBS and any future HDTV services will be. Some analysts are still skeptical that DBS services (HDTV or not) will be able to compete against the existing cable television industry. The DBS industry has been trying to get off the ground (figuratively and literally) for more than a decade now, and DBS efforts in the early and mid- 1980s ended in failure. The success of DBS and, in the longer term, satellite-delivered HDTV, will depend in part on the strength of competition from other video delivery systems in this country--cable, local broadcasters, multichannel multipoint distribution service (often known as "wireless cable"), and perhaps new fiber-to-the-home systems supplied by the telephone companies. With so many choices available to consumers, DBS and HDTV systems may have difficulty gaining enough customers to be viable.

In some cases, these technologies/systems are already gearing up to provide HDTV services. Cable systems, for example, have been aggressively laying fiber optic cables in order to increase their capacities—an increase that could be used to carry HDTV programming. Satellites will, however, have some advantages in the transition from regular television to HDTV. Compared with local broadcasters, there will be far fewer equipment changes in one or two satellites compared with hundreds of local broadcasting stations.

The regional, as opposed to global, allocations agreed to by WARC-92 are not expected to convey any relative advantages or disadvantages

---

175 Hughes recently signed a $250 million-deal with the National Rural Telecommunications Cooperative (NRTC), formed in 1986 by rural telephone and electric companies, who will retail the DirecTv programming and sell/lease the receiving equipment. The target market is the 12 million households served by NRTC members.

176 ''IS DirecTv Coming Alive at Last?' *Telcom Highlights International,* May 6, 1992.

177 Debra Polsky, ''Hughes DirecTv Deal to Bring Satellite Service to Rural Areas, *Space News, vol.* 3, No. 16, April 27-May 3, 1992, p. 4.

178 There are no licensing restrictions that would prevent DBS providers from offering HDTV programming.

179 It could take Until 2007 for this size demand to be built, so the lead time agreed to at WARC-92 may not be all that limiting.

in terms of global competitiveness.[180] In fact, the regional allocations of WARC-92 may serve to confirm and reinforce the trend toward divergent HDTV standards already being developed around the world. Originally, international spectrum managers hoped that the establishment of a single worldwide spectrum allocation for HDTV would facilitate the global deployment of HDTV and promote the development of one international standard for the production and transmission of HDTV programming. The establishment of a single standard, in turn, would have reduced the potential for interference between systems, and would mean that only one type of HDTV equipment would have to be manufactured, and no complicated conversion would be needed to show HDTV programming in different parts of the world.[181] However, technological developments in various countries and different choices on how to deliver HDTV programming to consumers have made it almost a certainty that standards will again be divided, making the establishment of a single BSS-HDTV frequency band less important.

## Terrestrial Aeronautical Public Correspondence

### BACKGROUND

Aeronautical public correspondence (APC) services allow airline passengers to place telephone calls while in flight (phone calls cannot yet be received by passengers). The systems use transmitters in aircraft to communicate with receiving stations at various locations on the ground. These ground stations then relay the telephone calls through the public telephone network to their final destination.

APC services were frost proposed on a global basis at the 1987 Mobile WARC (MOB-87). That WARC allocated frequencies in the 1.5-1.6 GHz band for APC experiments. However, in the United States and many other countries, these frequencies are heavily used for other services and could not be used for APC. As a result, the United States decided to operate APC services in the 849-851 MHz and 894-896 MHz bands. A number of companies in the United States currently provide such services, and several other countries, including Canada and Mexico, use these frequencies as well. The North American system is fully operational, and hundreds of aircraft have been equipped with equipment using these frequencies.

### U.S. PROPOSAL

The United States proposed that the 849-851 MHz (ground-to-air) and 894-896 (air-to-ground) MHz bands be allocated for APC use on a worldwide basis. This proposal was based on the extensive use of these frequencies for APC in North America.

### RESULTS

The U.S. proposal was not adopted, but the United States was successful in protecting its existing APC system. A primary worldwide allocation was made to APC at 1670-1675 MHz for transmissions from ground stations and in 1800-1805 MHz for transmissions from aircraft to the ground. The United States, along with Canada and Mexico, inserted footnote 700A specifying that they would continue to provide APC in the 849-851 MHz and 894-896 MHz bands.

---

180 Likewise, any competitive advantage that would normally convey to the company or country that develops a standard first, has also been lost. The world has already been effectively divided into three standards areas by policy decisions in the United States, Japan, and Europe, that each would have their own standard. Thus, the markets have already been predefine to a large extent, and the competitive race now has shifted to individual companies within regions, or in the case of the United States, a country.

181 Television programming is currently produced and transmitted in one of three incompatible formats: National Television Standards Committee (NTSC), Phase Alternation Line (PAL), and Systeme Electronique Couleur avec Memoire (SECAM), each of which are used by different groups of countries. The U.S. standard is NTSC.

### DISCUSSION

**The** APC debate again pitted the United States against the CEPT countries, which proposed that the 1670-1675 MHz and 1800-1805 MHz bands be allocated for APC service worldwide. The choices facing WARC-92 delegates on this issue were clear-support either the United States or Europe. No other bands were seriously considered. Although there was important support for the U.S. position in Region 2—the Western Hemisphere--other countries around the world did not back the United States, and the U.S. proposal was ultimately rejected. The CEPT countries were again able to muster strong internal and external support, and were uncompromising. Their strong position made the U.S. proposal difficult for other countries to accept.

### ISSUES AND IMPLICATIONS

As a result of the two sets of frequencies allocated by WARC-92, aircraft may have to carry two different kinds of equipment to provide APC services in different parts of the world. Alternatively, aircraft may have to be outfitted with new transceivers that operate in both bands and that presumably would be more expensive. This issue could be revisited at a future world radiocommunication conference if a dual system proves technically unworkable or economically undesirable.

In the long term, terrestrial APC systems may be augmented or even superseded by satellite technology. For example, Comsat, GTE Airfone, and Northwest Airlines have successfully demonstrated a satellite-based communications system for both cockpit and cabin telecommunications services.[182] The system, linked through Inmarsat satellites and Comsat's Earth stations, will provide global telephone and other communications services when aircraft are out of range of GTE's terrestrial network.

For the United States, the WARC-92 APC allocation could undermine the U.S. advantage in terrestrially-based airline communication systems. The United States is currently the world leader in developing APC services and providing communications services for airline passengers. Japan has focused its efforts on delivering such services via (Inmarsat) satellite. Until now, Europe has been unable to match the systems operating in North America because common frequencies to carry such services did not exist.[183] The WARC-92 decision essentially levels the APC playing field-erasing the previous U.S. advantage and starting development of and competition for such systems and services back at square one. The decision clearly benefits European APC interests by allowing them to "catch up" to American developers.

The longer-term implications of the decision are unclear. U.S. manufacturers of APC equipment will either be shut out of world markets altogether, or will have to retune production lines to manufacture radios compatible with the new world frequencies. This could mean producing to two different frequencies and sets of standards.[184] U.S. equipment makers will have to work hard to maintain their technical and market lead in APC in the face of divided markets and production inefficiencies.

## Fixed-Satellite Service at 14.5-14.8 GHz

### BACKGROUND

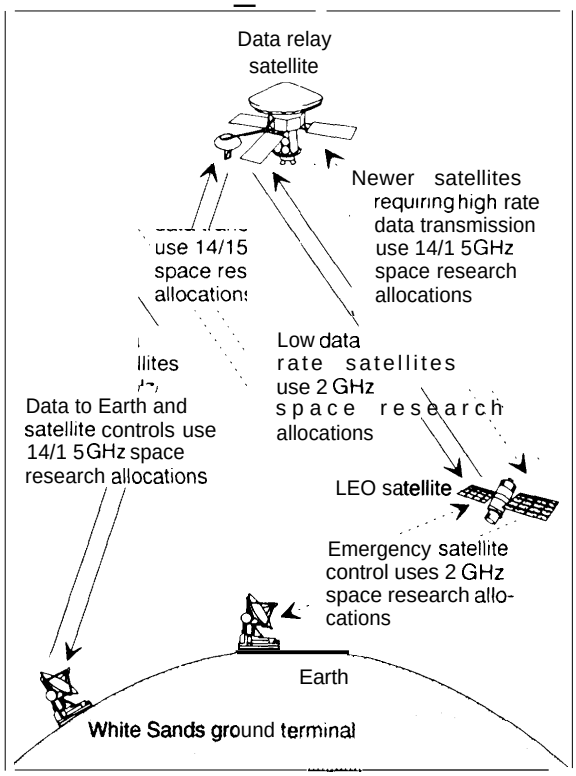
Fixed-satellite service (FSS) refers to communications systems that use satellites to link

182 "CCJIMSAT, GTE Airfone and Northwest Airlines Successfully Test satellite Communications," *Telcom Highlights International,* April 29,1992, *p. 17.*

183 'The Executive Office Arrives on Airliners,' *Telcom Highlights International,* vol. 14, No. 20/21, May 20, 1992, p. 23.

184 A draft CEPT recommendation proposes that only those phones that comply with Eurpean Telecommunications Standards Institute (ETSI) standards be allowed to operate in Europe. Evagora, op. cit., footnote 156.

**Figure 2-1 l-Data Relay Satellite System**




SOURCE: National Aeronautics and Space Administration, 1993.

stationary (fixed) satellite antennas on Earth.[185] The FSS is used around the world to provide long-distance communications links for telephone conversations, data files, and video programming. Currently, international use of the 14.5 -14.8 MHz band is limited to transmission of video programming for BSS, and is used extensively by Intelsat. In the United States, however, these frequencies are allocated solely for government use, and are used primarily to support Department of Defense operations. NASA also uses the band (on a secondary basis) to support its Tracking and Data Relay Satellites (TDRS), which relay data from remote sensing satellites to Earth (see figure 2-11). WARC-92 considered reallocating these frequencies in order to correct shortages in the amount of spectrum available for FSS uplinks relative to downlinks. The shortage was 500 MHz in Region 2 and 250 MHz in Regions 1 and 3.

### U.S. PROPOSAL

Because of existing uses in the band 14.5 -14.8 GHz, the United States strongly opposed reallocating these frequencies for FSS. The United States said it would not agree to any licensing of freed-satellite operations in the band, nor to protect such operations from interference from other users. As a result, the United States proposed that the allocation at 14.5 -14,8 GHz remain unchanged.

### RESULTS

**The** United States was successful in preventing WARC-92 from reallocating the band. Instead, the conference allocated 250 MHz to FSS uplinks at 13.75 -14.0 GHz. The allocation is coprimary with radiolocation services, and standard frequency and time signal-satellite and space research services are secondary. Two footnotes were added to the allocation. Footnote 855A specifies power levels and antenna sizes for Earth stations, and footnote 855B lays out a phase-in schedule for making FSS primary in the band. In addition, WARC-92 adopted Resolution 112, which calls on the CCIR to conduct sharing studies between FSS and the existing services in the band, and evaluate the impact of the FSS on these other services.

### DISCUSSION

**The** U.S. Government had put an absolute block on these frequencies in order to protect Department of Defense systems supporting national security interests. Intelsat, with the backing of many developing countries, strongly supported the reallocation, while some European countries sided with the United States in opposition.

185 These satellite antennas are the large dishes familiar to most people.

### ISSUES AND IMPLICATIONS

**The** FSS allocation at 13.75-14.00 GHz has mixed implications for the United States. On the positive side, government operations at 14.5 -14.8 GHz were successfully protected. On the other hand, the United States must now share 250 (out of 600) MHz of spectrum that had been devoted to active sensors, such as radar altimeters. The impacts of this sharing on the existing services in the band, especially the space services, are not known, and will be studied as noted above. Some protections are given to the existing services in the footnotes adopted by WARC-92. The United States may revisit this issue at a future conference in order to allocate additional frequencies for sensor applications or further protect existing services.

## Space Services

### SPACE RESEARCH AND OPERATIONS SERVICES BELOW 2 GHz

Background —The need for communications to support space activities by the nations of the world has grown significantly in recent years. Radio frequencies are used in space to communicate with manned spacecraft, to command and control satellites, to relay data from remote sensing satellites to Earth, and to communicate with astronauts working outside their spacecraft. The United States, for example, uses these frequencies during shuttle missions, for support of the Hubble Space Telescope, and may need them for future operations of Space Station Freedom.

The frequencies allocated to these communications and support services, like frequencies in many other bands, have grown increasingly congested over the years.[186] The 2 GHz bands, which were used for both the Apollo and Soyuz space missions, are becoming especially prone to interference because of their favorable transmission characteristics and high reliability. In 1979, there were just over 70 assignments for space uses of these frequencies. By 1992, this number had risen to over 300 assignments around the world.[187] The most recent and dramatic example of the congestion now plaguing space communications was demonstrated during the rescue of the Intelsat VI satellite by U.S. shuttle astronauts—interference was evident in conversations between the astronauts and their colleagues in the shuttle and on the ground.

U.S. Proposals-The United States had several proposals for Space Research and Space Operations Services in the 400-420 MHz and 2 GHz bands. In the band 400.15-401 MHz, the United States proposed that a footnote be added to the Space Research Service specifically allow space-to-space communication between manned vehicles in space-in support of docking maneuvers, for example. In the band 410-420 MHz, the United States proposed to add a coprimary allocation for the Space Research Service to allow communications in support of extra-vehicular activities (EVA)—work performed by astronauts while they are outside their spacecraft. These activities include such things as maintenance on both the shuttle and Space Station Freedom and future satellite rescues.

The United States proposed to upgrade allocations to the space services to primary status in various frequencies between 2025 and 2290 MHz. Previously, these bands had only been allocated to the space services through footnotes (747, 748, 750), and were subject to difficult coordination requirements under Article 14 of the international Radio Regulations. The proposed

---

186 WARC-ORB-88, for example, noted in Recommendation 716 the increasing use of these bands by the space research and space operation services, leading to increased coordination difficulties. Recommendation 716 further notes that this congestion may slow the development of such services. Both W= C-ORB-88 and WARC MOB-87 requested that a conference be convened to address these issues.

187 Robert Taylor, Spectrum Management Specialist, National Aeronautics and Space Administration, personal communication, July 10, 1992.

upgraded allocations (which would eliminate Article 14 coordination requirements) included[188]:

- 2025-2110 MHz to space research, space operation, and Earth exploration-satellite (uplink and space-to-space) services;
- 2110-2120 MHz to space research service (uplink for deep space activities-defined as distances greater than 2 million kilometers from the Earth); and
- 2200-2290 MHz to space research, space operation, and Earth exploration-satellite (downlinks and space-to-space) services.

Results-U.S. proposals were generally successful. In the band 400.15-401 MHz, the requested footnote was added to the primary space research allocation enabling these frequencies to be used for space-to-space communications. These frequencies will be shared among a number of services, including downlinks for little LEOS services. Spectrum was also allocated to the Space Research Service at 410-420 MHz, but on a secondary basis. It is likely that the United States will seek to have this allocation upgraded at a future conference, once interference and sharing concerns with terrestrial users are resolved.

In the 2 GHz bands, all U.S. proposals were accepted by the conference. However, a footnote was added to the bands 2025-2110 MHz and 2200-2290 MHz to protect communications between geostationary and non-geostationary satellites. WARC-92 also adopted Resolution 211, which calls for additional study of sharing between the space services and mobile services (see below) and Resolution 710, which calls for a future conference to consider upgrading the status of the Meteorological-Satellite and Earth Exploration-Satellite Services (401-403 MHz) to coprimary status.

Discussion and Implications-In years past, some ITU members had opposed the upgrading of the space services, primarily because of the possible interference they could cause to existing freed and mobile systems. Observers note several reasons for the change at WARC-92. First, the space services had been operating in these bands under their footnote allocations for many years. Experience had shown that sharing with the freed and mobile services could be accomplished, at least for some mobile services (see below). Second, the various space agencies of the world had been working on these issues before the agenda for WARC-92 was even set, and had already reached a tacit agreement in the Space Frequency Coordination Group (SFCG), composed of space agencies from around the world. That agreement was translated back to member governments and was used to build support for U.S. space proposals at WARC-92. As a result, a high degree of coordination and cooperation existed between SFCG members prior to WARC-92, making the negotiations for space services allocations at the conference relatively easy. Interestingly, CEPT was an important element of this process, since Germany, France, and the European Space Agency are all members of the SFCG.[189] The successful negotiation and resolution of the space issues serves as a counterpoint to the difficulties the United States had with the CEPT bloc in other areas, and indicates that the United States and Europe may be able to work together in the future.

Sharing between mobile services and the newly upgraded space services will be a subject of continuing study and experience. Sharing difficulties may limit the number and/or kinds of mobile services that can operate in the bands. Proponents of the mobile services point out that sharing has been demonstrated over time. However, this sharing has generally only been with

---

188 All these allocations would be on a coprimary basis and would share with terrestrial freed and mobile services.

189 As of November 1992, the members of the SFCG included: Argentina, Australia, Austria, Belgium, Brazil, Canada, China, European Space Agency, France, Germany, India, Italy, Japan, Netherlands, Russia, Spain, Sweden, United Kingdom, and the United States.

"low-density mobile systems, " such as electronic newsgathering (ENG) services. Resolution 211 notes that the introduction of conventional landmobile systems, such as cellular/PCS/FPLMTS-type services, would cause "unacceptable interference to the space services," and calls for the CCIR to continue its studies of protection for the space services from mobile services.[190] It also suggests that future limits on mobile systems may be needed to permit the services to continue to share the bands. This would clearly constrain the types of mobile services that could use the band, Until the CCIR finishes its studies, the resolution recommends that only "low-density mobile systems," be permitted-no conventional land mobile services such as cellular phone service or PCS/FPLMTS.[191] Resolution 211 also calls for a future conference to define the conditions for sharing between mobile and space services.

U.S. space service proponents won what they perceive to be an important battle against the increasing number of mobile services in the 1-3 GHz band. With their new status, and the new limits proposed in Resolution 211, the space services seem well-positioned to continue and expand their use of these 2 GHz bands. The limits proposed on mobile services, on the other hand, should not greatly affect future U.S. interests since the FCC's emerging technologies proceeding does not include these bands. The impacts are likely to be greater in Europe, with their increasing push for terrestrial mobile systems (although this will not affect FPLMTS, since it is not identified for use in 2025-2110 MHz or 2200-2290 MHz). The new allocations may also help to solidify the status ENG operators, of which the United States has many, since they apparently can share with the space services, and future competition from other mobile systems will be limited.

### SPACE SERVICES ABOVE 20 GHz

Background—As the bands around 2 GHz become increasingly crowded, space operations and services have had to look for additional spectrum at higher frequencies. Congestion in the 2 GHz bands is exacerbated by the ever-increasing bandwidth requirements of NASA's space operations, especially data collection from remote sensing satellites. For example, although NASA currently uses the 14 GHz bands for data relays, it is already considering higher bands (around 23/26 GHz) to serve future generations of satellites.

U.S. Proposals and Results--The United States had a number of proposals regarding various satellite-related and space services above 20 GHz. These are summarized below.

*Inter-Satellite Links: The* United States proposed to allocate the 21.7-22 GHz band to support links between satellites of the various mobile satellite services. These frequencies, for example, could be used to provide communications between satellites as envisioned in Motorola's Iridium system. The United States also proposed a primary allocation in the 25.25-27.50 GHz band for wideband space-to-space links to support space research and Earth exploration-satellite applications. These links would be used to transmit data, including high-resolution video, from low orbiting spacecraft such as the United States space shuttle or Space Station Freedom to geostationary data relay satellites, including the U.S. TDRS.[192] The existing intersatellite service allocation would be used for TDRS-to-user links in the 22.55-23.55 GHz band based on the availability of bandwidth and the feasibility of

190 ITU, *Final Acts,* Resolution COM4/2, op. cit., footnote 27, p. 81.

191 PCS and FPLMTS, however, are not currently proposed for use in these bands.

192 Four TDRS systems are now being developed-by the United States, the European Space Agency, Japan, and the Commonwealth Of Independent States. The United States system is the only one operational at this time, serving approximately 100 satellites.

sharing, See figure 2-11.193 In addition, these wideband space-to-space links could be used to provide communications between Space Station Freedom and a variety of space vehicles flying near it.[194]

The U.S. proposal for 21.7 -22.0 GHz was not accepted. However, an equivalent amount of spectrum (300 MHz) was allocated at 24.45-24.75 GHz for intersatellite service. For the wideband satellite links at 22.55-23.00, the BSS allocation was deleted to make more room for future intersatellite links. The U.S. proposal for a primary allocation at 25.25-27.50 GHz was accepted.

*Space Research Service Requirements: To* support domestic and international space research efforts, the United States proposed two new allocations. The first proposal was for coprimary allocations at 37-38 GHz (downlink) that would support space research activities such as Very Long Baseline Interferometry (VLBI) by satellite,[195] which requires wide bandwidths to send data. In addition, the 37-37.5 GHz (downlink) would also be used in conjunction with 39.5 -40.5 GHz (uplink) to provide communications with a planned station on the Moon and the mission to Mars in the 21st century. Because of the intense use of data communication these efforts will require, wideband radio links will be needed.

> There are no frequency bands allocated in the Radio Regulations that could be used for wide bandwidth links between the Earth and the Moon and between the Earth and Mars. Use of the same band for both sets of links is desirable because it would permit use of common equipment, ..196

The United States also proposed a worldwide upgrade for the Space Research Service (for deep space research-such as the Voyager and Viking interplanetary missions) to coprimary status at 31.8 -32.3 GHz (downlink) and 34.2-34.7 (uplink) to support increasing space activities in these bands. Currently, these bands are allocated to the Space Research Service worldwide, but only on a secondary basis, and not for deep space research. The United States, however, and 10 other countries had different allocations.[197] This disparity created a situation that the United States believed threatens future deep space research missions at a time when the trend toward international cooperative missions for deep space exploration creates the need for increasing unity and cooperation.

> There is a serious potential for interference to national and international deep space missions because the current allocations allow uplinks and downlinks for space research conducted by Earth orbiters to use the same bands as deep space links. These links are not compatible because of the widely different transmission [power] and received signal strengths, [198]

The U.S. proposal for space research (VLBI) and communication downlinks (for a lunar colony) at 37-38 GHz was accepted, but WARC-92 allocated only half the proposed amount for the uplink frequencies--4O-4O.5 GHz. Although this creates an imbalance in the frequencies available

---

193 Current TDRS satellites use 13.4-14.0 GHz for sending the&@ from the TDRS satellite to the ground station at white Sands, New Mexico. These space research frequencies, however, are only secondary (to radiolocation services). The next generation of satellites, however, will use government frequencies in the 20.2 -21.2 GHz band.

194 Portions of these frequencies may also be used to co remand and control remote robots working on the space station, and retrieving remote scientific modules that would be in orbit near the space station.

195 VLBI refers to measurements made using satellites that enable scientists to track geodetic movements on Earth and provide information on the changes caused by earthquakes.

196 U.S. Department of State, *u.S. Proposals,* op. Cit., footnote 5.

197 See footnotes 890 and 891 of the ITU, *Radio Regulations,* op. cit., footnote 19.

198 U.S. Department of State, *U.S. Proposals,* Op. Cit., footnote 5.

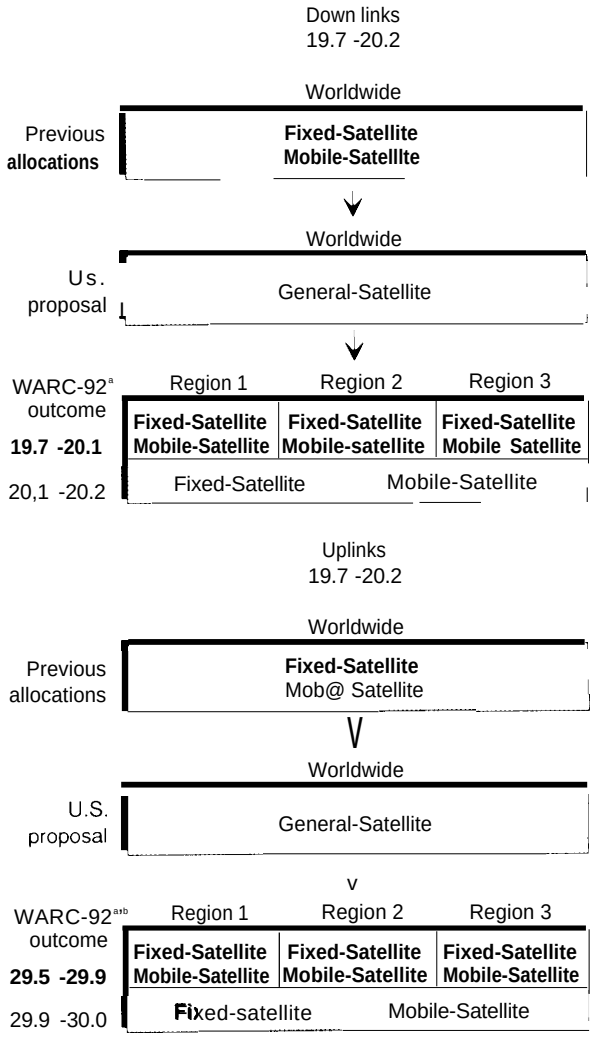
for uplinks and downlinks, the needs outlined above should be satisfied.

The U.S. proposal for deep space downlinks at 31.8 -32.3 GHz was accepted, but an existing footnote (893) designed to protect the navigation systems in the band could limit some uses. Sharing and interference criteria will have to be worked out on a case-by-case basis. The U.S. proposal for deep space uplinks at 34.2 -34.7 GHz was accepted. Additional allocations were made to the space research service (downlinks) on a secondary basis in the band 74-84 GHz.

*General-Satellite Service:* The United States proposed a new service, the General-Satellite Service (GSS) that would have operated at 19.7 -20,2 GHz (downlinks) and 29.5 -30.0 GHz (uplinks), and would have replaced current primary fixed-satellite and secondary mobile-satellite service allocations in those frequency bands. This proposal was based on efforts now underway in the United States to develop and implement communications satellites integrating a wide variety of capabilities on a single, flexible-use satellite. These include fixed, mobile, and point-to-multipoint applications. The U.S. (Government and industry) position is that such flexibility is needed in order to better match future satellite capacity with future satellite communication needs.

The concept of a General-Satellite Service was not adopted by WARC-92. The United States did win a minor victory by having MSS upgraded to coprimary status in 19.7 -20.1 GHz, but only in Region 2 (see figure 2-12). MSS was also made coprimary worldwide at 20.1 -20.2 GHz. Similarly, MSS was upgraded to primary status in 29.5 -29.9 in Region 2 and worldwide only at 29.9-20.0. However, a number of footnotes will affect the use of these bands. First, existing footnote 873 allocates these same bands to the terrestrial fixed and mobile services on a primary basis for large sections of Africa, the Middle East and Asia. Five new footnotes describe various limitations and conditions that MSS networks must meet to operate in the bands, including coordination requirements relating to the countries in footnote 873. WARC-92 also adopted Recommendation 719 that calls for studies to be conducted on the technical and sharing characteristics of 'multiservice' satellite networks.

Figure 2-12—U.S. Proposal for General-Satellite **Service**




a A number of footnotes further define the uses of these bands.
b This band is also allocated to the Earth **Exploration-satellite** Service on a secondary basis.

NOTE: Radio services in all capital letters are allocated on a primary basis. All others are secondary.

SOURCE: Office of Technology Assessment, 1993.

In line with the decisions of WARC-92, the FCC has adopted an NPRM to upgrade MSS to coprimary status in the 19.7 -20.2 GHz and 29.5 -30.0 GHz bands. The notice responds to a July 1990 proposal by Norris Satellite Communications to establish a general satellite service to provide fixed, broadcast, mobile, and personal communications services in the Ka-band. While the upgrade to MSS will enable Norris to operate many services, broadcast services are still not allowed. The FCC hopes that broadcasting experiments in the 20/30 GHz range as part of NASA's Advanced Communications Technology Satellite (ACTS—scheduled for a 1993 launch) will answer sharing and interference questions regarding shared use of the band by broadcasting and other satellite services. Depending on the success or failure of the ACTS experiments and Norris' efforts, the United States may pursue a GSS definition and allocation at future world radiocommunication conferences.

*Earth Exploration-Satellite;* Earth Exploration-Satellite Services (EESS) are being increasingly used by the United States to obtain higher quality data about the Earth and regions of the atmosphere that are not available through the use of other frequencies. To avoid the potential of future interference to these activities, the United States proposed a primary allocation for EESS (passive) allocations at 60.7 -60.8 GHz and 156-158 GHz.[199] However, because of domestic coordination and preparation problems, the 60 GHz proposal was withdrawn.

The 156-158 GHz proposal was accepted. Other EESS allocations made at WARC-92 include secondary allocations at 25.5-27 GHz (downlink-to be shared with the **intersatellite links** noted above), 28.5 -30.0 GHz (uplink-limited to data transfer), and 37.5 -40.5 GHz (downlink-shared with a variety of services).[200] A number of footnotes, however, which relate to the operation of the FSS in the 28.5 -30.0 GHz band will affect EESS operations, and may constrain future development of EESS services in that band.[201] Sharing and coordination arrangements will have to be developed for all these allocations.

*Radiolocation-Satellite Service: The* United States proposed to define a new space service, the Radiolocation-Satellite Service, and to provide a primary allocation for this service in the band 24.55-24.65 GHz. This new definition and allocation will provide for satellite-based location services to a variety of users.

The U.S. definition was adopted, but the proposed allocation was made in a slightly higher band-24.65-24.75 GHz, and only for Region 2.

Discussion—The U.S. proposals for space services were the most successful proposals the United States made at WARC-92. Much of the success of these proposals has been attributed to the work done prior to WARC-92 in the SFCG. As noted, this group provides a forum within which the space agencies of the world can discuss their spectrum needs and identify future spectrum requirements. This mechanism makes it much easier to precoordinate frequency allocations for space services and applications at international conferences such as WARC-92. The group also provides a mechanism for space agencies to build support for their proposals and generate cross-support among different nations.

---

199 The use of these bands for this type of data collection is "passive," meaning that radio waves being received by the satellite are merely measured and recorded for analysis. "Active" data collection on the other hand, is accomplished by a satellite sending out signals (such as radar) to a particular target (layers of the atmosphere, the Earth itself) and analyzing the signal when it returns.

200 A primary allocation was also made to EESS at 40-40.5 GHz.

201 Some of these footnotes were proposed by the United States to provide uplink power control systems that will be required to enhance FSS performance. Currently, the 27.5-29.5 GHz band is allocated to the FSS for uplink use only. A downlink signal is required to provide adequate information to control system performance. To accommodate a downlink transmission to support these power control systems, the United States proposed to add a footnote to permit the use of downlink beacon operations within the 27.5 -29.5 GHz band. This proposal was accepted, but was further refined and divided into footnotes 882A and 882B.

The problems with GSS were slightly different and more political in nature. The Europeans saw no need for the new service, maintaining that existing allocations provide adequate flexibility.[202] This view is similar to the European views on and opposition to the generic MSS allocation proposed by the United States. This recurring split may indicate either a deeper philosophical opposition to more generic, vague service allocations, or it may simply indicate a fear of, generic-type services on the part of the Europeans.[203]

Depending on the actual reason for this opposition, two factors may influence the success of future U.S. GSS (and generic MSS) proposals. First, the European preference for more stratified allocations may come from a stronger belief in planning and/or that more specific allocations are easier to use. The United States, on the other hand, generally has rejected *a priori spectrum* planning, preferring to let market forces dictate spectrum uses. Second, and perhaps more likely, economic advantage may be the driving force behind European opposition. It appears the United States has a slight technological lead in MSS and advanced space applications, and the Europeans may believe that GSS systems will give the United States a greater advantage in building systems and providing services in these new, and as yet undefined, allocations.[204]

Implications—The space communications allocations made at WARC-92 represent some of the United States' more clear-cut successes at WARC-92. The United States got most of the allocations it wanted in this area (with the exception of GSS), and seems well-positioned to move ahead with plans for future space missions and activities.

The implications for future GSS-type services are less clear. Proponents maintain that the allocations made will allow services very similar to what a GSS would have allowed-permitting *de facto GSS* systems to operate. This belief is probably overoptimistic. The various footnotes and political opposition associated with the so-called GSS bands will make establishment of a GSS-type service complex. The successful development of such systems by the United States or others will depend on how much the political opposition fades and the manner in which sharing arrangements are resolved. Systems will develop as negotiations allow.

202 Reportedly, an agreement to support some type of multiuse satellite concept was worked Out between representatives of the United States and CEPT. EC observers, however, apparently feeling that Europe had been too willing to compromise on other issues, decreed that no compromise on GSS would be acceptable. Consequently, the Heads of the European Delegations opposed the U.S. proposal.

203 It is interesting t. note, however, that the Europeans did support FPLMTS, a concept that is as poorly defined as GSS or generic mobile.

204 On the other hand, when the Europeans have the perceived advantage, as they do in terrestrial mobile systems, for example, the tables turn--the vagueness and flexibility (of FPLMTS) become acceptable to them, but not to the United States.

# Next Steps and Lessons for the Future

# 3

WARC-92 set the stage for the development of radiocommunication technologies and services for the next decade or more. Future world radiocommunication conferences will build on the agreements of WMC-92 in an attempt to bring high-quality communication services to people all around the world. In order to ensure the most effective participation of the United States at these future conferences, U.S. spectrum managers and policymakers must understand the context within which international decisions will be made, and the U.S. agencies primarily responsible for conference preparations and negotiations must adapt their cultures and structures to this new environment. The first test of the government's and the private sector's understanding of this new context will come in the implementation of WARC-92 decisions and their preparations for the next world radiocommunication conference to be held in the fall of 1993.

The consequences of ineffective U.S. participation in international telecommunications negotiations and rulemaking could be significant. The rules and regulations set at international fora, and U.S. responses to them, will substantially influence the development of new communications services and how well U.S. companies can compete in radiocommunication services and equipment worldwide. Economic, technical, and political factors must be integrated into a focused, long-term strategy for meeting U.S. radiocommunication needs. The lessons of WARC-92 can contribute to the realization of such a policy and strategy framework, and will enhance the effectiveness of future U.S. delegations and improve chances for U.S. "success" at future world radiocommunication conferences.



## INTERNATIONAL ISSUES IN WARC-92 IMPLEMENTATION

WARC-92 represented neither the beginning nor the end of work for spectrum managers and entrepreneurs worldwide. Rather, it marked the end of one phase and the beginning of another. With WARC-92 agreements finalized, member countries of the International Telecommunication Union (ITU) must now decide individually how to implement the allocations agreed to at WARC-92+1

### Foreign Allocations and Licensing

Like the United States, most countries usually accept the bulk of the international allocations and incorporate them into their domestic frequency tables. However, also like the United States, individual countries will exercise their right to adapt or ignore allocations they believe are not in their best interests or that will interfere with their existing uses of the spectrum. Because radiocommunication systems must be licensed in each country in which they plan to operate, a single country's refusal to license a service (or allocate spectrum for it) could jeopardize systems that are regional or global in nature, such as some broadcasting and mobile satellite services. At the least, one country's refusal (out of several countries in a given geographic area) to allocate a service or license a particular system will pose substantial engineering challenges. Service to neighboring countries, who have accepted the allocation and licensed the service provider, could be adversely affected.

Given the opposition expressed at WARC-92 toward some services, international acceptance of some proposed systems and services is still in doubt. At the conference, many countries, including the United States, indicated through footnotes to the allocation table that some services (using specific frequencies) would not be permitted to operate within their borders, or could not operate until after a specified date. The United States, for example, prohibited Broadcasting-Satellite Service-Sound (BSS-Sound) services from using L-band allocations in this country. Since Canada and Mexico have indicated that they will both use these frequencies, and since those uses will likely interfere with U.S. telemetry operations, coordination will be necessary in North America.

### Sharing and Coordination

The development of sharing and coordination arrangements among new systems and between incumbent and new users of the spectrum will challenge U.S. Government and private sector negotiators. Other countries will try to protect their existing services and gain advantages in service, price, or technical sharing arrangements. As noted in chapter 1, footnotes to the international Table of Frequency Allocations in some cases limit how, when, and where a service can be offered. For example, 75 countries joined together in a footnote that limits the operation of low-Earth orbiting satellites (LEOS) in the 148-149.9 MHz band to secondary status (see chapter 2). This could constrain or preclude operation of LEOS services in those countries. In addition, limits on power, such as those imposed on LEOS systems operating above 1 GHz (big LEOS), may also make coordination of new services difficult. Because the systems are not yet operational, the power requirements and characteristics of these new services are not yet known, and the limits agreed to at WARC-92 may not be practical. Negotiating the technical details that will allow different services to share frequencies will be contentious, as shown by the debate in the United States over the provision of big and little LEOS services (see chapter 2).

---

1 The agreements reached at WARC-92 will enter into force on Oct. 12, 1993, unless otherwise noted in the text of the Final Acts of WARC-92.

## Trends Affecting International Implementation

In addition to the themes discussed in chapter 1, the Office of Technology Assessment (OTA) has previously identified several broader trends that are shaping the evolution of world radiocommunication technology, services, and policy.[2] These include: rapid technological advances, globalization of systems and services, increasing regionalism, privatization and deregulation, and shifting geopolitical power centers and alliances. Each of these trends will affect how WARC-92 decisions are implemented.

### RADIO TECHNOLOGY IS ADVANCING RAPIDLY

The rapid development of new radio technologies and services have serious consequences for the implementation of WARC-92 allocations and regulatory decisions. First, the rapid changes and advances in technology make setting rules and standards for radiocommunications systems increasingly difficult. The decisions made at WUC-92 were necessarily made on the basis of today's technology, but some of these decisions will not come into full force for 10 to 15 years. During that time, the technical bases for the decisions or the technical parameters agreed to at WARC-92 are certain to change and become outmoded.

In an era where the product cycles for electronics are measured in months, not years, a rapid and flexible approach to standards-setting and manufacturing is vital to domestic and international economies, As rules and regulations continue to be negotiated both domestically and internationally, it will be important to not lock in technology solutions and systems that may be quickly superseded. Enough flexibility in the rules must be assured so that technology can continue to grow. A flexible approach will be extremely beneficial to U.S. companies-enabling them to take advantage of their radiocommunication expertise and research and development (R&D) strengths to quickly bring new technologies and services to market throughout the world. The United States explicitly recognized the benefits of such an approach in its proposals for generic Mobile-Satellite Service (MSS) and General-Satellite Service (GSS).

### GLOBALIZATION OF RADIOCOMMUNICATION

As the world becomes increasingly reliant on information services to sustain economic growth and productivity, the importance of global telecommunication systems increases. Companies seek to be more closely connected with customers, suppliers, and partners around the world. Individuals increasingly depend on and expect reliable communications wherever they are. Telecommunication systems serving these needs must be global in scope. The LEOS systems now being developed by the United States and other countries are designed to meet such needs.

The trend toward globalism was not well-served by WARC-92. At the conference, countries and groups of countries doggedly fought to have their own positions advanced and their own services protected, despite the almost universal recognition that global allocations would better promote the development of new services and reap higher economic benefits for all.[3] Compromise on many of the issues facing WARC-92 delegates was notoriously difficult, and countries

[2] U.S. Congress, Office of Technolgy Assessment *The 1992 World Administrative Radio Conference: Issues for U.S. International Spectrum Policy,* OTA-BP-TCT-76 (Washington DC: U.S. Government Printing Office, November 1991), hereafter, "OTA, *WARC-92*." The government of Canada cited many of the same factors as the driving forces behind its recent reassessment of Canadian spectrum policy. See Canada, Department of Communication, *A Spectrum Policy Framework for Canada,* Cat. No. Co 22-120/1992 (Minister of Supply and Services, September 1992).

[3] The benefits of a single worldwide allocation for any new service, leading to a single standard would provide economies of scale for manufacturers, allowing equipment prices to be lower, It is possible that the benefits of this situation may unevenly benefit the countries of the world—all countries and consumers would benefit from lower prices, but the other benefits (increased revenues and profits) to manufacturers would accrue only to those developed countries actually making the equipment.

did not hesitate to insert country-specific footnotes that either exempted them from specific decisions or made unilateral decisions to promote their own national interests.

In large part, the blows to worldwide allocations were spurred by the increasing importance of regional ties in world affairs. In Europe, for example, the convergence of economic interests and the emergence of a unified approach to economic policy has made the European countries much more active in promoting their economic self-interest, especially in telecommunications. In order to protect their existing radiocommunication services and advance European technology worldwide, the Europeans have taken a strong stance promoting uniquely European proposals and requirements. They are no longer quite so willing to follow the American lead in technology, preferring instead to stake out their own g-round.

Similar alliances, formal or more informal, exist in many other regions of the world as well, including southeast Asia, and, to a lesser extent, Latin America and Africa. As a result, instead of global allocations, WARC-92 adopted differing regional allocations for many important services including BSS-Sound and high-definition television, MSS, and aeronautical public correspondence. Such divisions may make future negotiations more difficult, and global allocations harder to achieve.

### PRIVATIZATION AND LIBERALIZATION

**Reflecting the new connection** of economics and telecommunications, perhaps the most important trend influencing the future of world radiocommunications is the increasing privatization of telecommunication services coupled with the increasing liberalization of markets and deregulation of telecommunication and radiocommunication industries. In the past, and to some extent, the present, one of the largest impediments to expanding the U.S. telecommunications presence abroad has been the monopolies and monopoly relations maintained by the government-controlled post, telegraph, and telephone administration (PTTs) around the world. As the sole supplier of telecommunications services and buyer of telecommunications hardware, these government institutions wielded tremendous economic and political power-power that was often used in concert with other foreign government policies to exclude U.S. companies from freely competing in many countries.

In recent years, however, in response to intense global competition in telecommunication equipment and services and user complaints about high costs and poor service, many countries have attempted to replace their traditional government telecommunication monopolies with more aggressive privately-owned companies and liberalized rules on provision of services and equipment. These trends represent a tremendous opportunity for U.S. companies to expand their markets and sales overseas. Combined with the increasing globalization of telecommunication services noted above, U.S. companies now have an opportunity to compete in countries they previously were excluded from.

The effects of liberalization and privatization also have led to a number of new players in world radiocommunications, and U.S. companies seeking to deploy their new WARC-approved services will face a different world than only a few years ago. Instead of one government ministry to deal with, U.S. companies may now be faced with a government ministry, a private national telecommunications company, and a plethora of competitors. Both potential support and opposition will be more diffuse, forcing American interests to be quicker to recognize potential allies and more agile in forming alliances with foreign national companies or even other foreign competitors-a trend already evident in the bidding for some foreign telephone system contracts. The implications of this trend are discussed in more detail below.

### THE FUTURE OF THE ITU AND SPECTRUM POLICYMAKING

Another important factor affecting the implementation of WARC-92 agreements will be changes in the structure and functioning of the ITU. In June 1991, the Administrative Council of the ITU endorsed the recommendations of a High Level Committee (HLC) that had been established to examine the procedures and institutional structure of the ITU and recommend changes that would allow the organization to more effectively carry out its responsibilities.[4] As a result of the HLC deliberations, the Council called for a special Additional Plenipotentiary Conference (APP) to be held in December 1992 that would consider the recommendations outlined by the HLC. The Council also established a "Drafting Group' of experts from various ITU member governments to develop revisions to the ITU's Constitution and Convention based on the HLC recommendations.[5] This Drafting Group, which the United States participated in, finished drafting the revised text in March 1992, and the APP took place as scheduled over the last weeks of 1992. The United States generally supported the changes recommended by the HLC, since it participated actively in the work of the HLC and the formulation of the recommendations contained in the final report.

In order to prepare for the APP, the State Department's Bureau of International Communications and Information Policy (CIP) formed a task force in December 1991 to develop U.S. positions and propose changes and/or modifications to the HLC recommendations. The meetings of this task force were held under the auspices of the national International Radio Consultative Committee (CCIR)/International Telegraph and Telephone Consultative Committee (CCITT) committees, the activities of which are also coordinated by the State Department. More than 60 representatives of the private sector and of the various Federal agencies involved in international spectrum matters participated in the work of this group. The task force submitted its final report in early December 1992, but has recently been reconvened to address how the United States should respond to the changes made at the APP.[6]

The APP adopted changes in three broad areas that will significantly influence the conduct of future ITU activities and world radiocommunication conferences.[7] First, ITU members adopted a new institutional structure that is intended to streamline decisionmaking and that gives greater emphasis to development efforts (see figure 3-l). Second, the APP laid the groundwork for expanding the role of the private sector in ITU activities, although many of the specifics of their participation in the new ITU remain to be worked out. Finally, the APP adopted a 2-year schedule for future WARCS, which have now been renamed ' 'world radiocommunication conferences. These new conferences will combine the traditional functions of WARCS for frequency allocation and revisions to the international radio regulations, with the functions of the CCIR's Plenary Assembly, which will form a separate part of the conference.

The most important, and potentially disruptive, of these changes is the conversion to a regular 2-year cycle of conferences. Because of the overlap in planning and preparation cycles, the 2-year schedule means that ITU members will be

---

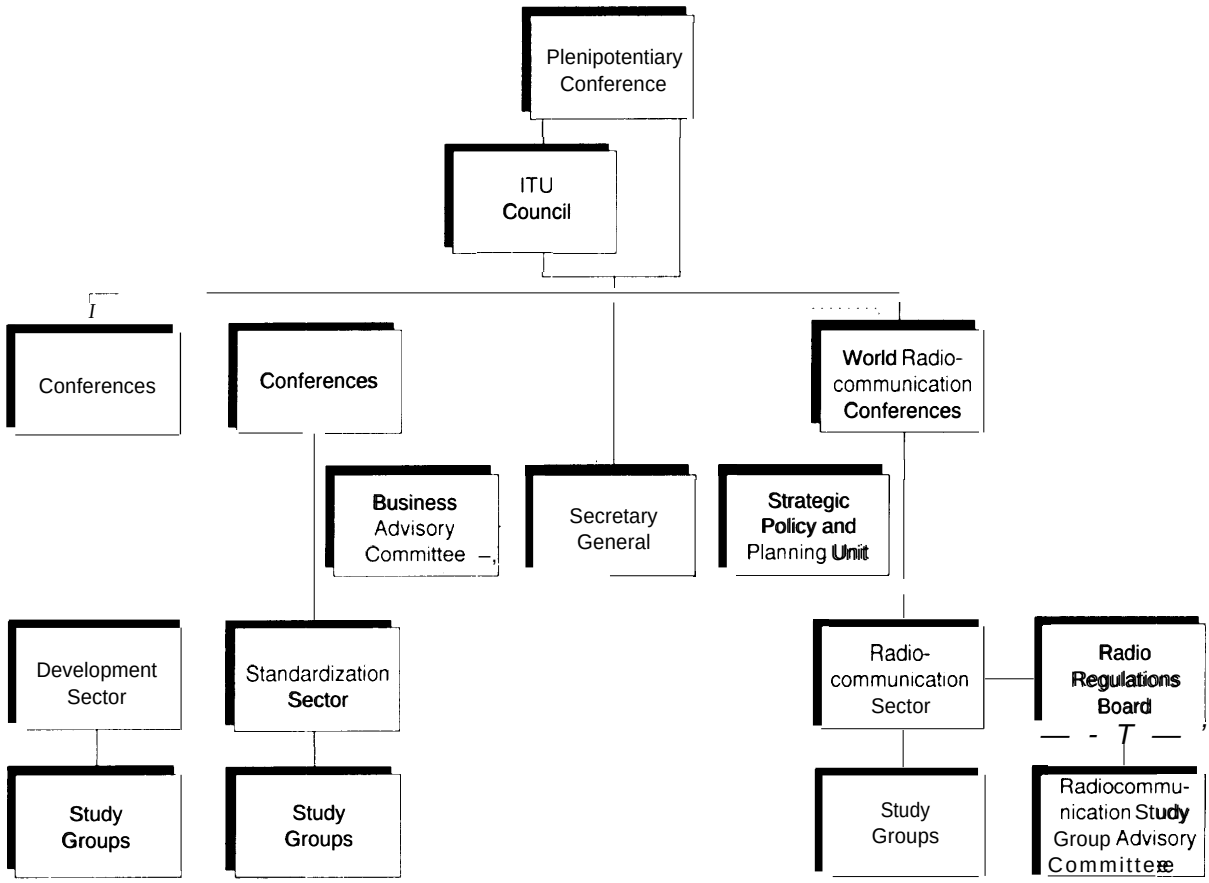
4 For further discussion of the HLC, see OTA, *WARC-92*, op. cit., footnote 2.

5 The proposed changes are being made to the ITU Constitution and Convention as approved by the 1989 Nice (France) Plenipotentiary Conference. However, this Constitution/Convention has not yet entered into force and ITU is still technically guided by the Nairobi Convention of 1982.

6 See ' 'Final Report of the CCITT and CCIR Joint Task Force, ' submitted to Ambassador Bradley P. Holmes, U.S. Coordinator and Director, U.S. Department of State, Bureau of Communications and Information Policy, Dec. 4, 1992.

7 For the complete text of the APP decisions, see International Telecommunication Union, *Final Acts of the Additional Plenipotentiary Conference* (Geneva, Dec. 22, 1992).

**Figure 3-l—New Structure of the International Telecommunication Union Recommended by the High Level Committee**




**SOURCE: Office of Technology Assessment, 1993.**

preparing for conferences constantly. In fact, each country will be preparing proposals for a conference at the same time that it is beginning planning for the following conference.

This change has important implications for how the United States prepares for future conferences. First, the 2-year schedule presents an opportunity for the United States to rationalize its budget and personnel approaches to world radiocommunication conference preparation. For those Federal agencies and private companies involved in the planning and preparation for these conferences, a 2-year cycle will put an enormous burden on both personnel and funding resources.[8] In the past, few, if any, resources were devoted exclusively to WARC preparations on an ongoing basis. In most cases, staff assigned to work on WARC preparations had other responsibilities that shared time and attention with WARC. Such an arrangement, while not necessarily ideal, was

[8] It should also be noted that few companies will have interests in each and every WARC that is held. Depending on the agenda for each conference, private sector interests will change, as will the relative participation of the various Federal Government agencies.

justifiable based on the sporadic nature of the WARCS, their varying agendas, and tight budgets. In the future, however, conference preparation and planning will require full-time attention on the part of all involved, but especially the Federal Communications Commission (FCC), National Telecommunication and Information Administration (NTIA), and the State Department. Adequate staff must be assigned to work on these issues, and enough finding must be secured to assure that these staff can do their jobs. In particular, enough money must be budgeted for travel and international bilateral/multilateral negotiations that lay the crucial groundwork for negotiating success.

The scheduling of regular conferences may also provide benefits in the U.S. radiocommunication policy process. Because of the continuous nature of the preparations, this schedule may force the United States to look forward more purposefully and identify longer-term requirements for domestic radio technologies and services. This, in turn, may also force the United States to develop more explicit strategies for pursuing these new goals, and could result in the development of a broader framework for identifying needs, prioritizing goals, and conducting negotiations—providing much-needed focus to the overall U.S. spectrum planning and management process.

It is too soon to assess the full range of impacts of ITU restructuring. The immediate changes in the structure of ITU will be dramatic, but the longer-term impacts on the mission, and the effectiveness of ITU in the face of new technologies, new players, and an increasingly privatized world are likely to be more subtle. As a result, U.S. policy toward ITU and its various organs and conferences is entering a period in which U.S. policymakers must be especially sensitive to the changes in the international telecommunication and radiocommunication arenas. Government policymakers and private sector representatives must continue to look ahead and share information with each other in order to best promote the competitive interests of the United States.

## DOMESTIC CONTEXT FOR WARC-92 IMPLEMENTATION

**The** decisions made at WARC-92 will be implemented in a domestic context that is complex and contentious. Radiocommunication policymaking is a world of dealing, bargaining and negotiating, and as in any politically charged forum, deals can fall apart and on occasion are sabotaged. The domestic battles now being fought over WARC-92 spectrum allocations and service rules are characteristic of strategies often used ‘‘inside the Beltway’ ‘—maligning the character of the competition, disputing every claim, relying on assumptions and half-truths, manipulating the media and Congress.

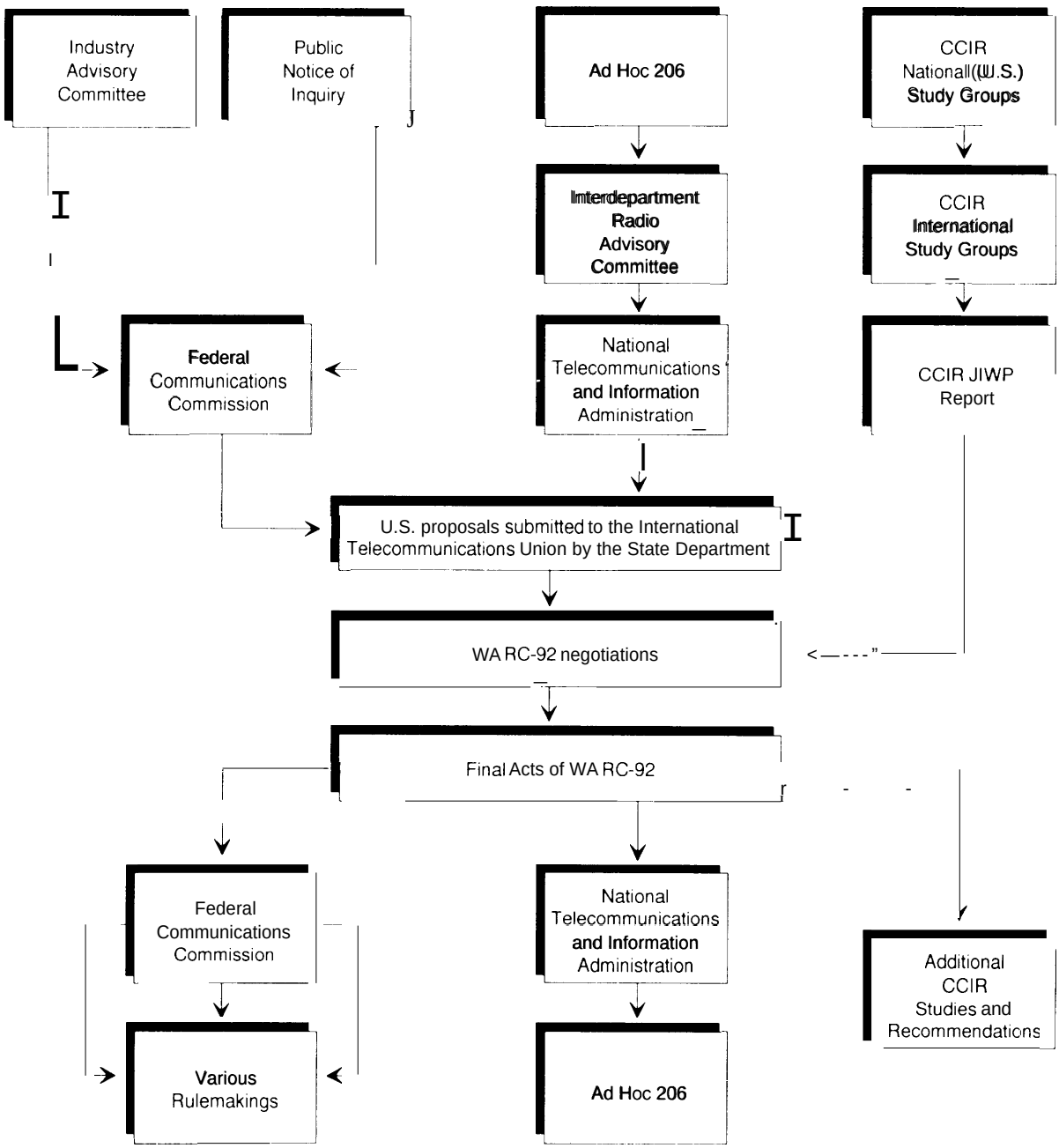
United States preparations for WARC-92 were concentrated in the FCC, NTIA and the State Department. The functions, processes, and issues involved in this 3-way division of responsibility have been previously discussed.[9] This section will examine the roles these agencies play in the implementation of the decisions made at WARC-92 and the larger role they play in developing U.S. radiocommunication policy.

### Federal Government Agency Roles

**In the** United States, responsibility for implementing the decisions of WARC-92 will be divided between the FCC and NTIA (see figure 3-2). The FCC is implementing decisions that affect the private sector and nonfederal use of the spectrum, while NTIA is implementing the decisions that affect Federal Government use of radio frequencies. Together, the two agencies must work out the necessary arrangements in those areas of the spectrum where Federal Government and private sector users must share radio frequencies. The State Department provides input to the

[9] OTA, *WARC-92*, op. cit., footnote 2.

**Figure 3-2-Steps in the Federal Government's Preparation for, and Implementation of, WARC-92 Agreements**




NOTE: CCIR = International Radio Consultative Committee; JIWP = Joint Interim Working Party.
SOURCE: Office of Technology Assessment, 1993.

FCC and NTIA in matters with important international repercussions. In almost every case, the battle over access to the newly allocated frequencies is fierce, and U.S. spectrum managers face many difficult choices in reconciling new interests with existing users and in choosing between competing systems promising similar services.

In the past, the FCC and NTIA had longer times to work out the details of implementation. The decisions of WARC-92, however, are being implemented more quickly for a number of reasons. First, as noted below, the FCC had a number of proceedings dealing with WARC-92 already in progress. Folding the agreements reached at WARC-92 into these proceedings can be done quickly. Second, the private sector is pushing for rapid action on these proposals, fearing that foreign and domestic competitors may enter the race now that allocations have been established. They also want to begin offering services and start revenue flowing as quickly as possible.[10] The result is that many highly visible issues, such as personal communications service (PCS), big and little LEOS, and BSS-Sound are already being considered by the FCC.

### FEDERAL COMMUNICATIONS COMMISSION

#### Implementation Issues

The FCC is the focus of much of the work now being done in the United States to implement the decisions made at WARC-92. In the past, the FCC usually initiated a single comprehensive proceeding to implement WARC decisions. In the case of WARC-92, however, the FCC already had several ongoing proceedings (begun prior to WARC-92) dealing with specific items that also appeared on the WARC-92 agenda.[11] Because of the important economic and competitive issues involved in several of these items, especially LEOS, the FCC is acting quickly to resolve those issues first, and holding less contentious issues for later action. These existing proceedings will provide the basic framework for FCC implementation of the W~C-92 agreements. Observers expect that the remainder of the allocations and implementation issues, including HF broadcasting, HDTV, and aeronautical public correspondence, will be dealt within one comprehensive proceeding. It will take several years for the FCC to adapt the WARC-92 decisions and allocations to fit national needs.

This incremental approach has both benefits and drawbacks. By considering a number of issues separately, the process may become fragmented at a time when a cohesive approach is needed. In many cases the frequencies to be considered in different proceedings overlap, but the services vying for the same bands might not be compatible. Many services, for example, are currently competing for frequencies in the 2 GHz band, including the existing users of the band (utilities, public safety agencies, and telephone companies), PCS, new space communication services (the responsibility of NTIA) and MSS.[12] It is not clear how these different proceedings will relate to each other. On the other hand, government officials point out that by separating the issues in this way, no one issue can hold up the consideration of the others. With the complex variety of issues decided by WARC-92, and the contentious nature of some of the issues, separating the items may be a better solution.

#### Challenges for the Future

The FCC, however, faces a number of problems that could hinder its ability to quickly and effectively implement WARC-92 decisions and

10 Fears of competition are often justified. Inmarsat, for example, immediately after WARC-92 concluded, announced its intention to use some of the new frequencies for future LEOS and/or geosynchronous satellite services.

11 These proceedings include proposals for emerging technologies, Personal communications services, little LEOS, big LEOS, and BSS-Sound.

12 Specifically, the bands involved are 1850-2010 MHz, 2110-2140 MHz, and 2160-2200 MHz, which all overlap to varying degrees between the FCC's Emerging Technologies proposal (for PCS), MSS allocations made at WARC-92, and the bands made available for Future Public Land Mobile Telecommunication Systems at WARC-92. See figure 2-4 in chapter 2.

that could undermine its long-term ability to effectively regulate the Nation's airwaves. First and foremost, the FCC has been put in the position of trying to do too much with too few resources. Funding at the FCC continues to suffer from past battles that took place between the agency and the Congress as a result of differences involving philosophy, approach, and specific FCC actions. As a result of chronically low funding levels, the FCC has weathered a siege of hiring freezes and staff shortages. Delays in beginning the negotiated rulemaking that will set regulations for the delivery of big LEOS services, for example, were attributed to staff shortages at the FCC. Had the agency's responsibilities remained static, these staff shortages might have been more easily dealt with, but they came at a time when the regulatory burden on the FCC was increasing. New radio technologies and services are being rapidly introduced, and the passage of the Cable Television Consumer Protection and Competition Act of 1992 has put even more pressure on the FCC's resources. [13]

As a result, the FCC's ability to effectively fulfill its mandate is hampered. By and large, the FCC can handle the day-to-day activities of regulating the Nation's telecommunications issues, albeit sometimes very slowly. However, lack of staff and funding constrain the Commission's ability to look forward and aggressively plan for the next generation of telecommunication services. "The handful of engineers and other technical specialists on [the FCC's] staff lack the resources to become deeply involved in technological planning and evaluation. Technology issues are taken over by parties battling for advantages in the marketplace, and the FCC just barely manages to referee these disputes."[14] brig-term planning is almost nonexistent in many areas, and in radiocommunications especially, the FCC has failed to develop a long-term strategy for managing the boom in wireless communications services. In short, the FCC has become primarily a reactive agency, with little ability to look forward.[15]

The second major constraint on FCC action is the litigious nature of American society. Almost every decision the FCC renders is challenged in court and often appealed numerous times. It is a sad fact that FCC decisions are often written with the expectation that they will end up in litigation.[16] While acknowledging the importance of overturning improper decisions, the consequences of this are to siphon staff time and resources away from aggressive (new) policymaking to defend past actions. Court battles also delay the introduction of new services for the American consumer, and cause uncertainty for equipment manufacturers and service providers alike. In an attempt to head off potential lawsuits in the implementation of WARC-92 decisions regarding big and little LEOS, the FCC used negotiated rulemakings that brought together all interested parties to work out acceptable compromises that could be written into FCC rules and regulations (see appendix E). This approach shows promise in some cases (like little LEOS), but its success in resolving more complicated and controversial issues has yet to be proven.

### Options for Improving the FCC's Performance

In light of current Federal budget realities, Congress has several options to improve the functioning of the FCC. First, require structural

13 Public Law 102-385, Oct. 5, 1992.

14 W. Page Montgomery, ''1992 at the FCC: The Year of the Paradox,' *Business Communications Review,* vol. 22, No. 3, March 1992, pp. 32-33.

15 FCC staff often explain their lack of anticipatory action by claiming that there is nothing they can do until someone or some company formally petitions the FCC for action.

16 Recently, the FCC has attempted to find alternatives to it procedures that would reduce the chances fOr litigation and streamline the regulatory process. See box 2-B.

and/or procedural changes that would concentrate more resources on international radiocommunication issues. For example, more focused and coherent international radiocommunication policymaking might be promoted through the creation of a formal or informal internal policy development group.[17] Given cur-rent staffing shortages and increasing responsibilities, this option may be of limited effectiveness without additional funds. Increases in the number and types of radiocommunication services and the FCC's new role in regulating cable television will continue to press FCC staff and resources.

Second, increase funding for the FCC. This money could either be targeted for international radiocommunications or come in the form of an across-the-board increase in the FCC's appropriation. Additional funding would allow the FCC to hire more engineering and legal staff to better handle an already large workload. More staff would also make it possible to redeploy staff resources to concentrate on international matters-those with international experience would be able to focus their attention on international matters. Increased funding would also allow FCC staff to participate more effectively in bilateral and multilateral meetings held in foreign countries-a crucial consideration when preparing for an international meeting such as a WARC.

Such increases could be provided for by changing the way the FCC is funded. Proposals have been advanced in the past that would allow the FCC to fund its operations, at least partially, through fees that it would charge radio licensees, or from the money to be raised by spectrum auctions. The added revenues produced in this manner could contribute a significant amount of money to the FCC's operations.[18] A combination of appropriated funds and fee-based funds could improve the FCC's performance, while keeping present funding levels and congressional oversight intact.

However, simply "throwing" money at the FCC will not solve its problems. Rather it would be a first step in a long-term campaign to boost the agency's efficiency and policymaking abilities. Just as crucial is the attention given to the importance of international issues at high levels, a more coherent focus for international radio policymaking, and a more forward-thinking and aggressive approach to policy. Successful policymaking at the FCC will result from a combination of changes/improvements in structure, funding, and philosophy. Setting specific goals for future policy development and reorganization of the FCC, perhaps through legislation, and closely monitoring progress toward those goals will be necessary to achieve better policymaking results.

### NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

#### Implementation Issues

NTIA, like the FCC, is now developing procedures for implementing the decisions made at WARC-92, especially as they affect government radiocommunication services such as space research and operations. NTIA will coordinate its efforts closely with the FCC because many of the frequency bands allocated at WARC-92 are used by both private sector and government systems. NTIA's efforts, however, are not as visible as the FCC's, because most of the high-profile systems and services are those to be provided by the private sector, and hence are regulated by the FCC.

NTIA's efforts to implement WARC-92 agreements will be influenced by two separate, but

17 As OTA noted in the past, FCC international staff are spread throughout various bureaus and divisions. Bringing all these experts together in one formal office would be almost impossible, given internal FCC politics. For this reason, a formal group could be convened that allowed staff to retain their current positions.

18 For example, the Congressional Budget Office estimates that spectrum auctioning of licenses for consumer land-mobile communication services could generate between $1.3 and $5.7 billion over 3 years. U.S. Congress, Congressional Budget Office, *Auctioning Radio Spectrum Licenses,* March 1992.

hopefully complementary, activities. The primary focus for NTIA's activities will be the Interdepartment Radio Advisory Committee (IRAC), which has retained Ad Hoc 206, its forum for WARC-92 preparations, and changed its terms of reference to include implementation of WARC-92 allocations and decisions.[19] In this process NTIA will coordinate its implementation and spectrum management activities with the FCC through both informal staff contacts and the formal participation of the FCC as a liaison to IRAC. In addition to the specific implementation issues to be worked out in Ad Hoc 206, NTIA has also launched a Notice of Inquiry dealing with future U.S. spectrum requirements, including the implications of WARC-92.[20] Presumably, the work of IRAC will inform this proceeding and vice versa. The outcome of this inquiry will be a report on national spectrum requirements and technology trends affecting long-range planning for new radio services.

### Challenges for the Future

The dual role played by NTIA in the domestic radiocommunication policy Process creates a significant problem in developing domestic and international radiocommunication policy. On one hand, NTIA is the executive branch advisor to the president on telecommunications policy. In this capacity, it should weigh all sides of the issues and present reasoned recommendations to the president. However, NTIA is also charged with the responsibility of managing the Federal Government's use of the spectrum. In this mission, it promotes the interests of the Federal Government spectrum users-a mission that often conflicts with its other mandate of providing rounded advice on telecommunications policy. In the past NTIA has seemingly put more weight on the government side of the equation. However, with the increased activism of the agency in the last several years, it has become more sensitive to the needs of the private sector and criticism that it is too "closed" to private sector input and cooperation. Steps have been taken to open NTIA activities to the public as much as possible.[21]

In addition to balancing its role as presidential advisor for all telecommunications issues against its advocacy for government spectrum users, NTIA must also confront the difficult task of balancing different agency needs and missions in the management of the Federal Government's use of the spectrum. As exemplified by the dispute over new allocations for HF broadcasting and the debate over use of the L-band, this task can often be highly contentious and political.

### Options for Improving NTIA's Performance

While NTIA is trying to improve its performance relative to the private sector, its conflicting policy responsibilities have not been resolved and, indeed, cannot be resolved by the agency itself. Action must be taken by the Congress and the Administration to determine just what NTIA's role and responsibilities should be and take the necessary actions to implement that decision—whether it be in the form of legislation, a new executive order, or as part of a more comprehensive effort to revamp all U.S. radiocommunication policy.[22] The specific options for resolving these problems are discussed in more detail in chapter 1.

---

19 Ad Hoc 206 is now chaired by an official from NTIA's Office of Spectrum Management. For a discussion of the role of IRAC and Ad Hoc 206 in the preparation of U.S. proposals, see OTA, *WARC-92*, op. cit., footnote 2.

20 U.S. Department of Commerce, National Telecommunications and Information Administration, "Current and Future Requirements for the Use of Radio Frequencies in the United States," Docket No. 920532-2132, June 1, 1992.

21 OTA *WARC-92*, op. cit., footnote 2.

22 In October 1992, Congress passed legislation that gives NTIA statutory authority (Public Law 102-538). This action effectively codified Executive Order 12,046, which had been the basis for NTIA's authority since 1978. Unfortunately, this legislation confirms the duality in ~'s mandate noted above.

## STATE DEPARTMENT

### Implementation Issues

The State Department is not directly involved in the implementation of WARC decisions in the United States. It does, however, provide input and coordination to the FCC and NTIA on international matters. In most cases, this involvement is through State Department coordination of and participation in bilateral and multilateral discussions with other countries about implementation of specific radiocommunication systems. The State Department also coordinates U.S. participation in the work of the CCIR and CCITT, the sections of the ITU that study telecommunications services and make technical recommendations on standards and system characteristics. The CCIR, especially, will play an important role in the implementation of WARC-92 decisions as a result of the conference's call for technical studies in many areas, including LEOS, future mobile services, space services, and BSS-Sound. The State Department is also active in coordinating U.S. activities with other international telecommunications organizations such as The Inter-American Telecommunications Conference (CITEL) and the European Community (EC).

### Challenges for the Future

The State Department plays an uneasy role in the U.S. radiocommunication policy process. It is the official representative of the United States in all formal international telecommunications meetings, such as WARCS. It also plays an important role in selecting the head of the delegation and providing most of the administrative support during the conference.

However, the role of the State Department is constrained in several ways. The State Department plays no direct role in developing or implementing domestic radiocommunication policy (e.g., WARC decisions), and has no authority over the radiocommunication policies of other executive branch departments. The State Department's almost nonexistent role in the development and implementation of domestic telecommunication policy limits its effectiveness in international radiocommunication policymaking and negotiations. Although State Department spokespeople are technically experienced and politically knowledgeable, many foreign delegates know they have no power over domestic implementation of international decisions. This may inspire them to deal directly with domestic regulators (FCC and NTIA) in order to streamline negotiations.

The Bureau of International Communications and Information Policy (CIP), which is the focal point for telecommunications within the State Department, has a relatively small staff of telecommunication professionals, and no formal engineering staff to support them. Established in 1982, CIP is also a relatively new addition to the State Department structure and, as a result, does not enjoy the prestige, status, or power of other bureaus in the Department.[23]

This relatively low position reportedly caused problems at WARC-92. There was initially little cooperation from other parts of the State Department in the preconference phase of negotiations, and members of the delegation leadership were frustrated trying to get things done through the Department. In part to solve this problem, Gerald Helman, a former ambassador and the U.S. representative on the ITU's High Level Committee, was brought onto the delegation to provide a better liaison with State Department officials.

These initial difficulties between the State Department and the U.S. WARC-92 delegation leadership also point out a more fundamental concern that must be addressed-the lack of

23 As noted in chapter 1, the State Department is now considering a restructuring that would place CIP under the Bureau of Economic and Business Affairs. This change may affect CIP's ability to carry out its coordination functions for international policy, and further reduce its stature in the State Department.

high-level attention to telecommunications policy in the State Department, and a lack of appreciation of the importance of telecommunications for international trade and competitiveness. It is clear from the pre-conference phase of WARC-92 preparations that the State Department can play an important role in promoting U.S. radiocommunication policy around the world. During that period, but only after much prodding, U.S. embassy staffs supported U.S. pre-conference efforts by meeting with high-ranking telecommunication officials in ITU-member countries and explaining and promoting U.S. positions. Such international support will be crucial before future conferences in light of the restructuring of traditional alliances and the rise of regional blocks around the world. Despite the relative success of such efforts, however, there is currently little evidence to suggest that higher levels (above CIP) of the Department understand or appreciate this potential role.

### Opt ions for Improving the State Department's Performance

Although many are critical of the historical role the State Department has played in past WARCS, and doubt its continued usefulness, other analysts believe that CIP and the State Department have an important role to play in negotiating international radiocommunication policy. As telecommunication becomes a more global industry, telecommunications policymaking will assume a more international character. As regional and worldwide communications systems develop and as geopolitical relations continue to evolve, the foreign policy aspects of U.S. international radiocommunications policymaking will become more important. The State Department, as the U.S. Government expert on foreign affairs, can play an important role not only in promoting U.S. interests abroad, but in formulating positions that have the best chances of acceptance in international fora—helping U.S. companies enter and successfully compete in new and existing markets. The State Department already has the basic framework in place-through its embassies-to make an effective impact on international telecommunications policy. Neither the FCC nor NTIA has this advantage. Those who believe that continued State Department involvement in the international telecommunications policy process would be beneficial have argued that restructuring and strengthening CIP would solve its past problems.

Strengthening CIP may require revising its mission and restructuring its staff. A clearer role in developing international telecommunication policy may be needed. CIP must make a serious case for itself within the State Department in order to show its relevance to the conduct of foreign policy. Most importantly, an overhaul of CIP would require a commitment from senior State Department leaders to integrate telecommunications issues with foreign policy considerations. Remodeling CIP would probably also require increased funding for travel and staff. The addition of a small engineering staff may help integrate ClP's role in international policy with its counterparts at the FCC and NTIA.

An alternative is to strip the State Department of its authority in telecommunications entirely, and move its fictions to another agency--either an existing one or a new agency for radio and telecommunication development. The specific options for restructuring are discussed in chapter 1. Given the uncertainties of the new ITU process, it is imperative that Congress decide what role the State Department should have in international telecommunications policymaking and representation. If action is not taken, CIP will continue to struggle in its present form. Congress can influence international telecommunications policy through CIP, but that leverage could be more effective.

One potential roadblock to the State Department increasing its role in the area of telecommunications is the division of responsibility between the State Department and the U.S. Trade Representative (USTR). The EC letter to Ambassador Baran (see the section on LEOS in chapter 2) requesting a meeting on LEOS licensing and

coordination raised two important public policy questions that have not yet been adequately addressed. The first issue is a fundamental question of what agency in the United States should be in charge of, or participate in, telecommunications meetings and negotiations that involve trade. Historically, the USTR has handled all negotiation between the United States and the EC. In this case (LEOS), the USTR did participate in the meetings, but not substantively. In the future, however, as trade and telecommunications issues become increasingly blurred, such an easy resolution may be hard to come by, and friction could develop between the State Department, NTIA, and the USTR. In order to avoid future turf wars, rights and responsibilities should be clearly outlined.

A parallel issue raised by the EC request is who does the United States deal with in Europe on telecommunications matters—the EC's telecommunications committee or European Radio Communication Office (ERO)? The divisions and uncertainties in the European telecommunications structure present an opportunity for the United States. And while the United States obviously has no direct input into how the various roles and responsibilities ultimately are divided, a careful study should be made and steps taken to ensure the best interests of the United States.

## WARC-92: LESSONS FOR THE FUTURE

### Conference Preparations

#### PRIORITY-SETTING AND GOVERNMENT POLICY LEADERSHIP

Because of the limited, and increasingly congested, nature of the radio frequency spectrum, setting priorities for its use is critical to ensuring the effective and efficient development of radio technologies and services in the long-term. Policies must be developed, with appropriate input from the private sector, that promote the development of new technologies and that also protect vital public safety and defense interests. WARC proposals and positions, because they help set the international context for all radiocommunication development and use, are thus critically important in this regard. Unfortunately, both before and after WARC-92, the government has been consistently criticized, by both members of the private sector and the government itself, for its lack of leadership in developing U.S. proposals and positions for the conference.

Two primary factors contributed to this lack of leadership. First, as noted in chapter one, the U.S. approach to spectrum policymaking and WARC preparation is based primarily on a democratic, market-driven model that tends to be reactive rather than forward-looking. And while this approach allowed the United States to produce decisions (WARC proposals) on time, it is less clear that those decisions were (and are) in the best long-term interests of the country. The apparent success in setting WARC-92 proposals quickly obscures the fact that long-range strategic planning on the same issues is almost nonexistent.

One incident in particular from WARC-92 illustrates the impacts that a lack of focused leadership and inadequate priority-setting can have. During the preparations for the conference, a conflict developed over the U.S. position with regard to the use of the L-band. Here, two clear policy issues clashed—support for big LEOS versus support for the future Global Navigation Satellite System (see chapter 2). The United States found itself in the politically difficult position of supporting two different uses for the same frequency band--one a private sector use backed by powerful companies promising billions of dollars in revenue and the other an international system for improving air safety and navigation that was already partially planned and coordinated. No policy determination was made to support one use/system or the other. Rather, the U.S. delegation tried to finesse its position to support both proposals, despite evidence that the systems could not share the same frequencies. The conflict will continue as the United States and other nations try to reconcile the decisions of the conference regarding these two services.

The second factor underlying the lack of focused government leadership is the divided structure of the radiocommunication policy process. Each of the agencies involved in the WARC preparation process has its own priorities. The FCC is concerned with promoting the interests of the domestic radiocommunication industry and U.S. radio service users. NTIA's primary concern is to protect the Federal Government users of the spectrum, while also promoting the competitiveness of U.S. companies overseas. The State Department, based on its mandate for advancing foreign policy, is most concerned with negotiating the best deal once positions are set. Unfortunately, these three perspectives and the differing missions of the various Federal agencies can often give rise to divergent policy directions and conflicts over the 'best' policy alternative. More to the point, there is currently no effective mechanism that stands above the agencies that can mediate such policy-oriented disputes when they arise.

But the deeper problems created by a divided policy structure and lack of leadership may be more subtle and far more serious. As noted in chapter two, during the consideration of additional allocations for HF broadcasting, a conflict developed between private broadcasters and U.S. Information Agency (USIA)/Voice of America (VOA), who wanted additional allocations and other government agencies, who opposed further allocations for broadcasting in the band, noting its extensive use for drug interdiction activities. In many respects this situation mirrored preparations prior to WARC-79. In both cases, VOA lost its case in the traditional preparation process of IRAC, and appealed the decision to the National Security Council (NSC). Before WARC-79, NSC accepted VOA's position. In 1992, however, NSC did not rule on VOA's request until after the conference had ended, effectively nullifying the appeal.[24]

The issue of whether VOA was justified in its request is not the crucial issue. The more fundamental questions involve the policymaking and appeals processes-are they fair and adequate, are they adhered to, and, ultimately, do the decisions made reflect the best interests of the American public? Because of the different interpretations of events leading up to WARC-92 and because much of the negotiations over HF broadcasting spectrum took place in the closed proceedings of IRAC, it is difficult to determine what really happened, and when. It is clear that a policy process is in place, but what is less clear is how closely and fairly formal procedures were followed, and how much each side took advantage of the process. Some government and private sector representatives from the HF broadcasting community believe that they did not get a fair hearing of their requirements in the U.S. preparatory activities, leading some to claim that a policy "deal' was struck between the FCC, NTIA, and other government users. They similarly feel that the appeals process was not handled in an aboveboard manner by those involved. They point to this instance as part of a more general problem in the way the IRAC/Ad Hoc 206 process works-a process they view as biased against broadcasting interests specifically and against smaller, less powerful agencies in general.

NTIA rejects this view. Agency officials maintain that there is no bias in the IRAC policymaking process, and that in the case of HF broadcasting, proper appeal procedures were followed.[25] They point out that VOA was actively involved in

---

24 NSC subsequently rejected the VOA position.

25 In cases where a disagreement exists, the normal procedure is for the issue to be passed to progressively higher levels for resolution. Thus the debate (in the IRAC preparation process) over additional frequencies for HF broadcasting moved from Working Group A of Ad Hoe 206 to the full membership of Ad Hoc 206, to the full IRAC, to NTIA, where a policy decision was made, and finally to the National Security Council. While this process is well-understood, it is also possible that both sides can use the process to their own advantage. There is evidence that both sides manipulated parts of the process in order to advance their negotiating strategies.

the IRAC process, and that the FCC, which participates in the proceedings of the IRAC through a liaison, did support VOA's and private broadcasters' position. As a result of the preparation and appeals process, NTIA decided that the existing uses of the band were more important than VOA's planned uses, and consequently made a policy decision not to support VOA's requests.

Complicating the analysis of this situation is the secrecy that tends to shroud the deliberations of IRAC and its preparations of Federal Government positions.[26] Because many of the government's uses of radio frequencies support classified activities, IRAC meetings have historically been closed to the public. This contributes to an impression that hidden agendas are being pursued and protected under the veil of ''national security.'' This perception is reinforced by a belief that government users may not always fully document their use of the spectrum to the public.[27] FCC staff, who represent "the public,' do attend IRAC meetings, but it is unclear how forcefully they articulate private sector interests in such meetings or how much information they can pass on to private sector representatives. Some commenters have noted that the FCC liaison is an effective force within IRAC, well able to represent the interests of the private sector. Other private sector commenters, however, are not convinced that the FCC always represents them as forcefully as it could.

Since IRAC meetings are mostly closed to the public, such claims and beliefs are difficult to evaluate. In the case of HF broadcasting, there is no way to discern at what level the decision was actually made, who made it, what policy dimensions were considered, and how carefully private sector concerns were addressed. There is no way to check what information was provided by the existing users of the band, and there was no open discussion at the policy level of which agency mission was most important in this case-the public diplomacy mission of the VOA and others, or the use of the frequencies to support drug interdiction efforts. However, it should not be assumed that because VOA did not have all its requests granted that the process is biased. On the other hand, the fact that VOA did get some of what it wanted does not prove the fairness of the process either.

On a more general level, secrecy leads to an impression that government frequency use information is not being shared. Some believe that it may not even exist. Again, because of the closed nature of the proceedings, an objective analysis of such claims is difficult. The agencies participating in IRAC negotiations maintain that they do share information, and that inadequate frequency data is also a problem with the FCC. Executive branch officials also point out that at certain points, internal debate at the FCC is **just as** closed from public view as is the IRAC process—at some point, (public) inputs must be closed off and a decision made. While this is true, the workings of IRAC are generally more difficult to analyze--it is still unclear what inputs are made and how they are considered. Decisionmaking may need to be closed off, but accountability must also be built into the system to the extent possible. A way must also be found to insure the accuracy and completeness of both government and private sector frequency data, and to provide adequate access to it for those with legitimate needs. Basing policy

26 NTIA has taken steps t. open the IRAC process so that its activities are more accessible to the public. This includes a public presentation period at the beginning of each IRAC meeting. For further discussion of NTIA's plans, see U.S. Department of Commerce, National Telecommunications and Information Admiistration, *U.S. Spectrum Management Policy: Agenda for the Future,* NTIA *Special* Publication 91-23 (Washington DC: U.S. Government Printing Office, February 1991).

27 The extent to which government spectrum users must disclose and describe such use is unclear. NTIA official.s maintain that they require users to support their proposals. What constitutes adequate support in this context is not defined. Especially in cases affecting national security uses of the spectrum, even NTIA officials may not Imow exactly where where, or how extensively a given frequency or band of frequencies is used.

decisions on flimsy or anecdotal data is no way to formulate good public policy.

In general, critics of the IRAC process complain that few high-level, open policy determinations were made that could have guided the WARC-92 preparation process, and solved major disputes like HF broadcasting. Instead of being guided by policy goals and accepted priorities, the overall approach to WARC-92 preparations was topic-oriented and ostensibly consensus-driven, both within the Federal Government's IRAC proceedings and in the FCC's Industry Advisory Committee. Unfortunately, this approach does not necessarily ensure that the best proposals are put forward, only those that are supported by the strongest (politically and/or financially) proponents and the best lawyers and consultants. This may lead to cases in which the "little guy" gets trampled-their concerns expressed but discounted. In such cases, consensus can become in practice little more than a rubber stamp for the wishes of the most powerful.

The HF broadcasting case also highlights the tension between NTIA's mission as Federal Government spectrum manager and its role as presidential advisor on telecommunications-it must walk a fine line between what the Federal agencies (as represented in IRAC) want, and what is good for the country as a whole. Policies and decisions involving Federal Government spectrum use, based on the consensus of the Federal users involved, may not reflect the larger public interest. In such cases, it is possible that the spectrum manager mission supersedes its advisory role, and private sector interests may lose out to Federal Government interests. The outcome of the HF debate provides little evidence either way. HF broadcasting interests did get additional allocations, but they did not get as much as they wanted. From this broadest perspective, regardless of how the decision was made, claims of bias toward Federal agencies are not supported; neither are claims that private sector interests were well-represented and fairly considered.

The overarching question becomes: Who is making U.S. Government communication policy? Based on what principles and concerns? In lieu of guiding policy directives from above, it appears that Federal policy is often developed out of the consensus-based process of IRAC. This, in and of itself, is not necessarily improper, but with such a heavy concentration of defense-related interests serving on that committee and a lack of clear policy guidance, it is unclear if the workings of IRAC represent a ''level playing field' on which all agencies can get a fair hearing of their needs and in which the best interests of the public are served.[28] It is also not clear that IRAC has the authority or is at the appropriate (high-enough) level to deal with fundamental questions of policy-especially since IRAC is chartered in only an advisory capacity to NTIA, which is formally charged with developing policy and managing the radio spectrum.[29] The appeals process for IRAC decisions is well-defined, if time-consuming. It should be noted, however, that an effective appeals process does not compensate for or justify a poor policy-development process.

---

28 As of February 1992, the membership of IRAC consisted of: the Departments of Agriculture, Commerce, Energy, Health and Human Services, Interior, Justice, State, Treasury, Veterans Affairs, Air Force, Army, Coast Guard, National Aeronautics and Space Administration, Navy, Nationat Science Foundation, U.S. Information Agency, U.S. Postal Service, Federal Emergency Management Agency, General Services Administration, Federat Aviation Administration, and a liaison from the Federal Communications Commission. The Defense Information Systems Agency, National Communications System, and National Security Agency participate only as observers. IRAC is chaired by unofficial from NTLA's Office of Spectrum Management.

29 NTIA has noted this tension itself: ''Since the IRAC chairman is the Deputy Associate Administrator of [the Office of Spectrum Management] and most of the subcommittee chairmen are also NTIA employees, it may appear to some that NTIA decisions are actually made by IRAC or vice versa. The advisory role of IRAC and the decisionmaking role of NTIA should be clarified and the ability of the IRAC to develop independent policy proposals emphasized. " NTIA, op. cit., footnote 26, p. 22.

## PREPARATION OF OFFICIAL PROPOSALS AND NEGOTIATING POSITIONS

Despite some problems, initial U.S. preparations for WARC-92 went well. The official proposals were developed on time (with some exceptions) and were among the first to be submitted to ITU. However, once that process was completed, the development of negotiating positions and strategies (based on the formal proposals that were submitted to ITU for WARC-92) became difficult. Several factors combined to make this happen. First, the multitude of private sector and government views were very difficult to blend. A broad range of interests, a large number of participants, and the lack of government leadership noted above are cited by most observers as contributing factors.

Second, an almost universal complaint heard from both private sector and government delegates and analysts was that the official U.S. delegation was chosen and officially named much too late in the preparation process. This complaint has been made a number of times in the past. Critics argue that the delegation must be picked and announced well in advance of the conference if the United States is to develop effective positions and if the members of the delegation are to learn to cooperate. Although an informal core of industry and government representatives had been preparing for WARC-92 well before the conference, uncertainty about the makeup of the delegation and the government's efforts to preserve the secrecy of U.S. positions, made the drafting and elaboration of fallback positions and negotiating strategies difficult.

These problems led some observers, foreign delegates, and U.S. delegates to complain that developing formal and final U.S. negotiating positions took too long. The result was a lack of firm positions and strategies that made early preconference diplomacy very awkward. The unsettled form of U.S. positions had the further effect that, in many international bilateral and multilateral meetings (such as the CITEL meeting held in Washington, DC in May of 1991), the United States could not forcefully push (renegotiate) its views because they were not set. Some delegates believe that having more time to "sell" the U.S. positions, for example BSS-Sound and HF, would have produced better results at the WARC.

While more time to lobby for U.S. positions could have helped promote U.S. interests, the U.S. process could not have worked much faster. The timeline for WARC-92 was set by the ITU at its June 1990 Administrative Council meeting, and the United States was one of the first countries in the world to submit its proposals, which were some of the most detailed and comprehensive presented to the conference.

Another complaint about how proposal and position development was handled involves information on other countries' proposals and positions. Critics complain that foreign positions were not adequately considered in the preparation process.[30] Preconference meetings between countries were a good source of information, but critics charge that such information was not integrated into the preparation of U.S. positions and strategies. One example these critics cite is the U.S. proposal for BSS-Sound/digital audio broadcasting. In this case, existing domestic use of the L-band outweighed international opinion; going into the conference, worldwide support for the U.S. S-band proposal was almost nonexistent, while strong support existed for L-band and other S-band allocations. The result of the U.S. prepara-

30 See Cements of the Institute of Electrical and Electronics Engineers before the National Telecommunications and Information Administration, Notice of Inquiry in the matter of Current *and Future Requirements for the Use of Radio Frequencies in the United States,* Docket No. 920532-2132, released June 1, 1992.

tion process, however, left the United States with little flexibility at WARC-92.[31]

While this may be true, such charges may also be a matter of perception. In any case they point out the tension in balancing domestic needs and requirements with international concerns. In some cases, the United States will have an overriding interest in protecting its existing services, like aeronautical telemetry, just as other countries do. Attributing this decision to a lack of flexibility or sensitivity to international concerns is not necessarily accurate.

Since good preparation is the key to a successful conference, an examination should be made of ways to allow U.S. representatives to negotiate more effectively before the conference, while still promoting the democratic ideals of participation that characterize the U.S. process. Some analysts note that the root of U.S. inflexibility lies in the nature of its preparation process. This process, which is the result of long, and often contentious debate, results in positions that are often very rigid—there is no time or will to review the issues again. This can force U.S. delegates to negotiate from difficult and inflexible positions—a situation that closely resembles the Conference of European Postal and Telecommunications Administrations (CEPT) negotiating style, according to some U.S. delegates. These analysts suggest that starting from a position that is not quite so set and specific may have benefits in allowing delegates more room to negotiate. Starting with more flexibility could lead to better outcomes in the long run.

An inevitable tension arises between making decisions that allow U.S. interests to advocate U.S. proposals and closing off debate too early. With adequate time and resources, the U.S. process works well. In cases such as WARC-92, where deadlines were short, the process works less well. In entering an era in which conferences will occur every 2 years, it becomes more important to reach decisions in a timely fashion. Ways must be found to speed the process while at the same time allowing all voices to be heard.

## Preconference Negotiating

### EXTENSIVE PRECONFERENCE NEGOTIATION IS CRUCIAL

**One clear lesson from WARC-92** is the importance of extensive and open (as much as possible) talks with other countries prior to the opening of the conference. Such talks, either informally between staff, or in more formal bi- or multilateral meetings give countries an opportunity to present their positions and gauge support and/or opposition to them, get information on other countries proposals, and begin to find areas of common ground on which to cooperate or areas of disagreement that will require negotiation and support-building. Such contacts are a crucial forerunner to the conference itself, and represent an important opportunity to refine positions and gather intelligence for future negotiations. Although the United States did conduct meetings prior to WARC-92 in an attempt to inform other countries of our positions and concerns and gauge potential support or opposition, many delegates feel that more extensive prenegotiation would have been beneficial.

Delegates and observers had several complaints about the way in which preconference meetings were handled. Some observers have complained that in some cases, the key spokespeople for the United States did not participate in the bilateral talks that were held with many countries. Government and private sector analysts have noted that such participation by experts is crucial in the early stages of WARC prenegotiation because it informs other countries what the U.S. positions are and provides crucial early feedback that should allow U.S. negotiators to further

[31] A similar problem confronted the European countries prior to WARC-92. Their telemetry operations used frequencies in the 2300 MHz range, making it impossible for them to support the U.S. position. Each side's position was made inflexible by existing uses. In the last clays of the conference, however, some European countries did break ranks and support the L-band allocation proposals.

refine and develop positions and strategies that have a better chance of success at the conference itself. Such meetings also provide an opportunity for private sector representatives to explain (sell) their systems in great detail, including an explanation of how such new systems would be implemented, how they might affect existing radio services, and what benefits would come from using the new systems and services.

Several factors contributed to this problem. First is the fact that the official delegation was named so late in the preparation process. The individuals who would later become spokesmen for the United States had not even been officially named to the delegation, In a few cases, the people who did make these trips were not the most knowledgeable about the subjects to be discussed and were not the ones who later represented the United States at WARC-92. Another reason for this is a matter of time: U.S. experts and government spokespeople were needed in the United States to help develop policies and positions, but at the same time, they were also needed to participate in bi- and multilateral discussions abroad.

Finally, a lack of travel funds hindered the participation of some key individuals at early meetings. The FCC, for example, which should have been represented on any meetings with foreign representatives, was able to send only one or two representatives because of limited travel funds and other work commitments, and these were often not the FCC staffers who were expert on the topics, who were involved in the preparation of proposals and (fallback) positions, and who became delegates to WARC-92. These choices deprived the United States of building or strengthening relationships with foreign delegates and prevented in-depth (more technical) discussions on some topics prior to the conference.

Another complaint heard about the conduct of preconference negotiations is that at least two potentially important trips (one a trilateral meeting with the United Kingdom and Russia in Moscow and another a tour of a number of countries in Africa) were canceled at the last minute. Explanations as to why the trips were canceled have been vague, although turmoil in the former USSR has been blamed for the cancellation of the Moscow trip. Meetings were rescheduled with some of these countries.

Some delegates have also complained about the distribution of the bilateral meetings held before the conference. There was apparently a heavy concentration of meetings with CEPT representatives, but less contact with other potentially important countries. In retrospect, Ambassador Baran has stated that, given CEPT's reluctance to compromise, he thinks time would have been better spent working with other countries. The expansion of work with the CITEL countries may provide a useful forum in this regard.

In addition to the bilateral and multilateral meetings scheduled as part of WARC preparations, CCIR activities provide an important forum for explaining U.S. views and systems. U.S. (government and private sector) representatives were active in the work of CCIR study groups. These study groups, which meet periodically over a number of years, consider specific allocation/regulation topics, and develop (technical) recommendations on WARC agenda items. These recommendations provide crucial input to the work of the conference, and often carry great weight in the deliberations. The work of CCIR in preparation for WARC-92 culminated in a Joint Interim Working Party meeting in March 1991. The product of this meeting was a voluminous report that contained all the technical recommendations to WARC-92 concerning frequency requirements and suitable allocations for the various services under consideration, frequency sharing and interference criteria, and other technical recommendations.[32]

32 For a more in-depth discussion of role of the CCIR and its study groups in WARC preparations, see OTA, *WARC-92*, op. cit., footnote 2.

Several observers have noted the important, if underrated, opportunity such meetings offer for developing support for U.S. proposals. Because the United States is one of the world's leaders in developing radiocommunications technology, and because membership in the study groups is more open to private sector input and more limited (in numbers) than that of the WARCs, U.S. companies play a leading role in the technical studies undertaken in CCIR. Thus, the United States (through the papers it develops for the study group topics) can have a significant impact on the recommendations developed by CCIR and hence on the work of the WARC itself. Some observers believe that more extensive and effective work in the CCIR fora before the WARCs leads to more successful outcomes for the United States at the conferences. In addition, the activities of the study groups not only offer important opportunities for building support for U.S. proposals, but also expose U.S. representatives to other countries' ideas-allowing the United States to take better account of them in our formal proposals. Given these benefits, the activities of CCIR should continue to be an important focus of pre-WARC negotiations.

### THE NEED FOR NEW ALLIES

The increasing power of Europe as represented by the CEPT coalition has important implications for future preconference negotiation strategies. U.S. experts in international spectrum policy recognize that Europe will be the single most powerful force in the ITU for some time. Prior to WARC-92, meetings that were held between the United States and CEPT were not very productive. Each side attributed this to the other's lack of willingness to compromise. Preconference negotiations suffered because of this, and, as a result, WARC-92 deliberations were made more difficult because few issues could be resolved before the conference.

In order for the United States to most effectively address the new power of the European countries, many analysts believe that more regular meetings with the Europeans will be necessary for U.S. spectrum managers to monitor European views and directions, and to gauge their future positions and assess their response to U.S. proposals. This approach will allow U.S. representatives to gather intelligence on European goals and to more easily cooperate with them on issues of mutual interest. The important advantage of early talks and greater cooperation (than was evident prior to WARC-92) with CEPT is that conference negotiations could be easier, and the United States would gain a strong ally that could help in defeating proposals from other blocks of countries. The new ITU conference schedule will also force more regular meetings between the United States and Europe as they prepare for conferences every 2 years, providing increased opportunities for cooperation.

Although the power of CEPT was clearly evident at WARC-92, it did not ensure success on all issues. Many countries were put off by the lack of flexibility on the part of the Europeans (and the United States) and their unwillingness to compromise or negotiate on some issues. Reportedly, even some European delegates were unhappy about the lack of flexibility CEPT showed. Delegates from both the United States and CEPT. countries recognize that such a lack of willingness to compromise made the work of WARC-92 much more difficult. This recognition provides an important opening for the United States to work with CEPT to resolve disputes before both sides become too committed to them and incapable or unwilling to compromise.

As a complementary approach, in order to counter the power of CEPT countries, Western Hemisphere countries are seeking to build the strength and unity of CITEL. CITEL has long been an underused resource in harmonizing Western Hemisphere telecommunications views, but before WARC-92 serious efforts were made

to bring North and South American interests together.[33] CITEL countries did meet several times as a group at WARC-92, but no substantive agreements or common views could be developed, in large part because of infighting between member countries (including the United States) for control of the agenda of the group and the outcomes on various issues.

Despite its relative ineffectiveness at WARC-92, CITEL remains an important potential source of support for the United States in the future. Historically, it has been held back by a lack of status, a lack of recognition of its importance by CITEL member governments, and a consequent lack of adequate funding to produce meaningful results. Gradually, these factors are changing. There is a growing recognition of the importance and promise of CITEL among both U.S. and foreign government officials. If the promise is to become reality, however, this recognition must be backed up by renewed efforts to compromise and increased funding.

It is unlikely that CITEL will become another CEPT--a collection of countries with common positions that cannot be changed easily. The telecommunication interests, economies, and political structures of CITEL member countries are too diverse to promote that level of collaboration. Rather, CITEL members see it as a way to improve coordination and cooperation between themselves, and exploit common interests where possible.

The United States will also have to engage in more extensive preconference negotiations and meetings outside the developed countries. Building on the alliances developed before and during WARC-92, a new program of extensive outreach to the developing countries of Asia, and especially Africa, could pay important benefits at future ITU conferences.

### RESOURCE CONSTRAINTS HAMPERED NEGOTIATIONS

One of the most serious limitation on preconference negotiations was lack of resources. Many delegates have noted that the meetings held prior to WARC-92 were hampered because key government spokespeople often could not make the trips. Lack of adequate travel funds was the primary factor limiting more active participation of government representatives. As a result, there were a few occasions on which some matters could not be discussed because they were too technical for those U.S. representatives present. The seriousness of this limitation is open to question.

The State Department, through its Office of Internationa1 Conferences, controls (some of) the funds that pay for U.S. participation in all international conferences, including WARC-92. Funds from this office are used to pay for the administrative costs of U.S. attendance at the conference (computers, office rental, supplies, etc.), and to pay for the head and the vice-chairs of the delegation, along with two or three support staff. Beyond those individuals, the question of who the State Department will pay for is always hotly contested. The Office of International Conferences has limited funds, and each Federal agency—including CIP--vies for additional staff. The agencies must cover remaining staff costs out of their own travel budgets.

While State Department funding is used to pay the administrative expenses of the conferences, travel funds for preconference meetings usually come out of individual agency budgets. For agencies such as the FCC, which has operated on a chronically tight budget for many years, this meant that its representation on bilateral talks was often limited to one or two people or none. Agencies with larger budgets, such as the National Aeronautics and Space Administration, had

33 Several meetings were held by CITEL in preparation for WARC-92. The goal of these meetings was to generate common views that CITEL members could use as a guide in developing their own country's WARC-92 proposals, Although this goal was not achieved, the meetings were extremely valuable achieving the broader objective of increasing the cooperation and unity of the countries of the Western Hemisphere. See OTA, *WARC-92*, op. cit., footnote 2.

fewer difficulties. The State Department also has funds to send U.S. Government representatives to meetings of CCIR at which bilateral meetings could also be conducted. This way of "piggy-backing" one meeting on another allowed the United States to send issue experts from agencies that could not afford the costs themselves.

The funding for future world radiocommunication conferences must be rationalized. The sporadic nature of past conferences made them very difficult to budget for—travel budgets varied wildly from year to year. The regular schedule of conferences planned for the future will make setting travel budgets easier. However, the funds to support the continuous series of bilateral preparation meetings and the funds for the conferences themselves must match this ambitious new schedule.

### BUILDING BROADER SUPPORT FOR U.S. PROPOSALS

In addition to the targeted prenegotiation that takes place before WARCs, a number of delegates and observers have identified the importance of long-running U.S. efforts that have helped build support for the United States. The best example of such efforts is the United States Telecommunication Training Institute (USTTI), which provides technical training to spectrum managers and technicians from developing countries. A number of WARC-92 delegates from other countries were graduates from this program. Although it is not possible to assess the direct impacts of this program and U.S. training of foreign nationals generally on the support for U.S. proposals, many delegates believe that the exposure to U.S. ideas and technology that these students receive is important in building a broad base of support for future U.S. radiocommunication policies.

## CONFERENCE MANAGEMENT

### Head of Delegation

The head of delegation's job is to have U.S. proposals adopted at WARC-92. Because of the generally late selection of heads of delegation, Ambassador Baran played almost no role in the development of U.S. proposals. As is the normal process, proposals were developed in concert by the FCC (for private sector issues) and NTIA (for Federal Government issues). His primary function, therefore, was as a negotiator--conducting preliminary/exploratory negotiations with foreign countries before the conference, and working during the conference to resolve the most difficult issues that could not be resolved in lower-level working groups. The Ambassador was also responsible for the day-to-day and strategic management of the delegation at the conference itself.

### RADIOCOMMUNICATIONS EXPERT?

One of the criticisms heard during the preparation for WARC-92 was that Ambassador Baran was not a radiocommunications expert, nor even particularly knowledgeable about international telecommunications. Some believe that the head of delegation should be well-versed in radiocommunications, which would eliminate the need for time-consuming education (essentially on-the-job training) of an ambassador prior to the conference. Others believe, however, that the most important skills for a head of delegation involve leadership, international experience, negotiation skills, and an understanding of politics. They point out that an intelligent individual can learn the issues and surround him/herself with experts to filter and explain technical details that arise. Ambassador Baran fell into this latter category and, by most accounts, did a good job in familiarizing himself with the issues.

These divergent views are not irreconcilable. WARC-92 was an extremely wide-ranging conference. It addressed many technologies, services, and issues, a number of which were leftover from previous conferences. A single individual would have difficulty mastering all the topics that were discussed at WARC-92 in such a short period of

time.[34] Past WARCs, with the exception of the general WARCs such as WARC-79, concentrated on narrower topics such as mobile services or HF broadcasting or satellite communications. In such cases, it may be possible for an individual to understand the range of issues addressed by the conference. Because future world radiocommunication conferences are expected to be more limited in scope, it may be possible to find a head of delegation who is well-versed in international negotiation and knowledgeable of the issues.

### TERM OF APPOINTMENT

One problem identified by observers critical of U.S. WARC preparations in the past is that the U.S. head of delegation, who receives temporary ambassador status (but does not get paid by the government), is chosen too late in the preparation process. The reason for this is that there is a 6-month limit on the terms of temporary ambassadors. Before WARC-92, Ambassador Baran was selected, and began working in late 1990, although he was not formally sworn in until August 1991.

The length of a head of delegation's term complicates the management of preconference meetings and preliminary negotiations. Although Ambassador Baran began (unofficially) working on WARC-92 issues roughly 1 year before the conference, some preparation activities and meetings had been scheduled and were taking place before he started. The result was that U.S. representatives were participating in many meetings around the world covering a number of topics—a confusing array that sometimes conflicted with directions the Ambassador was trying to take. Individuals sometimes had to be 'grounded" in order to have the preparations work at home be rationalized with the need for meetings abroad.

To solve such problems, some have suggested that the ambassadorship should be a fixed-term appointment-perhaps 4 or 6 years. Consequently, the position of head of delegation is most often mentioned in connection with a permanent agency to coordinate U.S. planning and preparations for international radiocommunications conferences (see chapter 1). Among WARC-92 delegates and observers, opinion is split over whether the United States should have a permanent head of delegation, and, if so, what requirements and responsibilities should go with the post. Such a position could, if properly conceived and set up provide a valuable focus for future WARC preparations. A permanent head of delegation could bring consistency to delegation management and the preconference negotiations that form an important part of WARC outcomes. A longer appointment could also provide continuity to U.S. conference activities-preparation, negotiations, and implementation-and would allow an individual to build experience that is not lost when the conference ends. On a broader scale, a longer freed-term appointment could provide continuity to U.S. negotiating efforts before, during, and after WARCs—building trust and relationships among foreign heads.

Among those who oppose establishing a conference preparation agency and/or a more permanent head of delegation, many believe that the current system works the way it is—' 'if it ain't broke, don't fix it. " Many observers believe that a permanent (or fixed-term) head of delegation is not needed since continuity is provided in the members of the delegation itself. Other analysts warn that appointing a more permanent head of delegation could be difficult politically because such a move could create a power center in addition (opposition) to the FCC/NTIA/State Department troika. The officials in charge of conference preparation at these agencies could see the creation of such a post as a threat to their power. The creation of such a position would also further diffuse the policymaking procedures that are in place. Some fear the dislocations that would

34 Several observers have pointed out that some individuals on both the U.S. and foreign delegations were well-versed in most, if not tall, of the important issues discussed at WARC-92—experience gained over many years of participation in ITU activities.

result from changing the existing power structures and balances, and believe that changing the relations of NTIA, the FCC, and the State Department will result in less effective preparation. Such dislocations, however, would likely be short-term, and would dissipate after a settling-in period.

If a freed-term appointment is adopted, an examination must be made of what role the head of delegation is expected to play—what rights and responsibilities will the individual have? In making this analysis, a number of factors will have to be considered. What type of background should the head of delegation have? As noted, many have argued that the head should be someone with radiocommunication experience. Others argue that diplomacy and international negotiating skills are more important at the top level. If a freed-term appointment is not made, it may be easier for a diplomat to learn the technology and issues and tap the experience and expertise of good (technical) advisors. On the other hand, an individual well-versed in radiocommunication policy would know the issues better. If a longer-term appointment is made, the question becomes somewhat moot; over the course of the term, the appointee could better learn all aspects of the job.

Should the position be full- or part-time? Conferences separated by many years may only have required a part-time position in the early stages of preparation. With ITU considering holding world radiocommunication conferences every 2 years, a full-time position may be more appropriate.

Should the position be filled by a private sector or government representative? Since the position would likely be a presidential appointee, either is possible. Some private sector observers believe that the only way the private sector can be fairly represented is with a private sector head of delegation. A head of delegation chosen from the government, they argue further, would be too enmeshed in the institutional battles of the agencies involved. Government interests, of course, would rather see one of their own in the position. It may also be difficult to convince private sector individuals to serve 4 years and then leave (if the post is nonsucceeding).

A related question is whether or not the head of delegation necessarily needs to be an ambassador. At WARC-92, some heads of other delegations were ambassadors, some were not. Some maintain that naming an ambassador for WARCS is overkill, that the connotations of the term take it out of the more technical realm of the WARC and contribute to the political nature of the negotiations. Others believe that the rank of ambassador conveys an important level of status that is useful in negotiations and that it underscores the U.S. appreciation of and commitment to the WARC process.

## H Divisions of Responsibility

The division of responsibility for domestic spectrum policy and the problems it creates have been previously discussed.[35] The problems of a divided structure were also evident at WARC-92. Foreign delegates reportedly had a difficult time deciphering the U.S. delegation and were confused by who was in charge of U.S. policy on specific topics. Several factors contributed to the complexity of the U.S. delegation. First, the delegation itself was large. There were multiple layers of leadership, including the head of delegation, six vice-chairs, the official U.S. spokesperson for each major committee, a spokesperson for each subcommittee and working group, official delegates, the support staff, and the observers. In addition, delegates were assigned as liaisons to specific countries or observer groups on major issues. This structure was overlaid by the distinctions between FCC, NTIA, State Department, and private sector representatives. To some foreign delegates the U.S. Government delegates may

35 OTA, *WARC-92*, op. cit., footnote 2.

have seemed indistinguishable, but the more savvy delegates know that responsibility for implementing WARC-92 decisions will be divided between the FCC and NTIA, and they would prefer to negotiate with those who are likely to be involved in actual implementation. One simple solution that has been suggested is to publish a list of U.S. delegates and spokespeople for the various issues, and distribute it to foreign delegates at the beginning of future conferences.

In addition to contributing to foreign confusion, the divided nature of the delegation also led to questions among U.S. delegates about who was in charge-institutionally and personally. Reflecting the overall lack of focus at home, no one agency took the lead at the WARC. And while Ambassador Baran was in overall charge of the management of the delegation at the conference, he did not lead negotiations on most of the issues.[36]

The hierarchical structure and large size of the delegation also caused some communication problems in the delegation itself. Although the delegation leadership held daily meetings to discuss strategy, and full delegation meetings were held every other day, many delegates thought that communication between the delegation leadership and the delegates was poor—that information was passed up to delegation leaders, but information from the leadership was not passed down. Several members of the delegation complained that there were too many layers of management, and that they were never sure what the leadership was doing.

## Execution of Negotiating Strategies

There is some question over how flexible the United States was at WARC-92 and how flexible the United States should be in WARCs generally. As with the evaluation of outcomes, perceptions of ''flexibility' are highly variable and depend on the individuals and issues involved. Critics complain that before and during WARC-92 negotiations in Spain, the United States took a very hard line on many issues and refused to really negotiate. This is reflected in comments that the United States did not really try to accommodate foreign positions in its proposals or preconference negotiations and spent more time on selling U.S. positions rather than negotiating a solution.

Members of the delegation leadership maintain that the United States was flexible on all but a few issues. The truth lies somewhere in between. As is usually the case in international negotiations, the United States was more willing--more flexible-to negotiate on some issues than on others. Different issues had different degrees of flexibility attached to them based on the outcomes of the initial preparations process and the way that (fallback) positions were written.

Several U.S. and foreign delegates have noted that a lack of flexibility in some U.S. positions often left the United States isolated on important allocation issues. To foreign observers, the U.S. delegation and its leadership often appeared to be held hostage to previously established positions and decisions. In order to (substantially) deviate from formally established U.S. positions and strategies, the U.S. delegation was required to constantly communicate with the home team for instructions and approvals. This added time to the negotiation process and frustrated some foreign delegates, who saw the United States as effectively unable to participate in on-the-spot decisionmaking that occurs throughout the conference, especially in the closing days.

Some analysts and observers, from both the United States and foreign countries, have noted that the United States was just as inflexible on some issues as U.S. representatives charge CEPT was. The reasons for this perception vary. Some

[36] Interestingly, Ambassador Baran has made similar Cements about the European block. CEPT, although presenting a coherent block at WARC-92, did have internal divisions and negotiating through them was quite difficult. There was uncertainty as to who controlled individual nation's positions—the delegates of the country itself, or CEPT leaders. Usually, CEPT positions won out.

attribute it to the slow preparation of positions and the late formal naming of the U.S. delegation and head of delegation. They point out that even late in 1991, the U.S. delegation had not been named and U.S. positions were still closely held—making preliminary negotiations between the United States and other countries extremely difficult, and by some accounts, not very productive. U.S. negotiators, however, rightly point out that certain U.S. positions had been set as a result of difficult domestic processes that concluded such inflexible positions were necessary and justified in order to protect and promote U.S. interests. They further note that a certain amount of secrecy is necessary to successful negotiations. Whatever the case may be, this inflexibility certainly contributed to the difficulty of negotiations at WARC-92.

Lack of flexibility maybe most directly related to our open, democratic form of policy development. Proposals and positions are so hard-fought in the preparations process that it can be very difficult to modify positions rapidly enough to effectively negotiate at international conferences such as WARC-92. Too many interests have to be considered and consulted to allow reaction times as quick as some delegates would have liked. Other delegations reportedly had more flexibility to make decisions without such consultations. Changes may be required in the instructions given to the delegation that would allow U.S. negotiators greater latitude in future negotiations.

Another reason given for the lack of flexibility on the part of U.S. negotiators is that hard-line positions were part of the U.S. negotiating strategy. According to some accounts, the inflexibility of the U.S. delegation was not a problem, rather it was a deliberately conceived part of a strategic framework designed to achieve the greatest possible success for U.S. proposals. Staking out positions early and refusing to compromise may in fact have forced some countries to move further toward U.S. positions than they would have under a scenario of mutual cooperation, but the opposite may also be true. Some countries, especially CEPT countries, may have become less willing to negotiate in the face of U.S. determination.

One solution to these problems is to invest the delegation with greater power and flexibility to negotiate, and to make the head of delegation ultimately responsible for the outcomes. This model is closer to that of several countries, including the United Kingdom. Such a solution, of course, has its advantages and disadvantages. The advantages are that the ability of the delegation to negotiate quickly is improved and that lines of authority and responsibility are clear. In the context of a new era of world radiocommunication conferences, change and flexibility will become more important. It may also be possible that with more narrowly focused conferences, the issues will be simpler to manage and the necessity of consulting extensively with the home team reduced. Giving the delegation more power alarms some analysts, however, who fear that such power could be abused. Changes in positions or negotiating strategies, for example, could be made without consulting all the affected parties or by ignoring the positions of some interests (see below). While such abuses will always be possible, the benefits of added flexibility and speed in negotiations may make the risk(s) worthwhile.

Because it is not possible to compare the advantages and disadvantages of each approach under real-world conditions in this case, it is difficult to judge whether or not inflexibility was the most appropriate or effective strategy for the United States to pursue. Did U.S. inflexibility hurt us in negotiations or in any way work to the detriment of the United States vis-a-vis the final outcomes? Could outcomes have been improved? Or were such strong stances necessary to achieve the goals and needs identified in the domestic preparation process? It is easy to believe on a theoretical level that greater flexibility would have better served U.S. interests in the negotiations both before and at the conference. The reality, however, may be that such a hard-line approach was best, and, obviously, U.S. negotia-

tors perceived it to be so (although others strongly disagree). Unfortunately, there is no way to objectively assess what *could* have happened if things had been different. The more relevant point is whether or not such absolute positions were necessary and how such positions were determined. The domestic preparation process again appears as a crucial element in the success or failure of U.S. proposals to WARC-92. It is these processes, and the structures and ideology underlying them, that must be carefully examined. In cases where the United States feels it must stake out an inflexible, and often isolated, position, it becomes critically important to carefully assess the reasons, benefits, and disadvantages of such an approach. As noted throughout this report, it is unclear to what extent such evaluations were made.

The larger policy/management question that arises is who has ultimate control of the delegation's actions. Prior to arriving at WARCs, the U.S. head of delegation is given a set of instructions drafted by the State Department in consultation with the FCC and NTIA that serve as the blueprint for how negotiations should be conducted. These instructions set out objectives and goals and list priorities and outcomes the United States could not accept under any conditions. Such a document, however, cannot possibly foresee all the twists and turns negotiations take. As a result, the delegation leadership must have some degree of flexibility to make decisions on-site. Substantial deviations from accepted U.S. positions are traditionally cleared through consultations with the U.S. home team. The issue is how much discretionary negotiating power the delegation should have vis-a-vis the home team and the agencies. The uneasy balance of power between the delegation and the home team blurs the lines of authority and obscures responsibility—confusing both foreign and U.S. delegates. Who is ultimately responsible for the conduct and outcomes of negotiations, the head of delegation, the home team expert on specific topics, or the broader collection of home team representatives?

One example from WARC-92 illustrates the problem. In discussions over MSS, as noted previously, a major U.S. concern was preserving the 1435-1525 MHz band for aeronautical telemetry uses. At WARC-92, however, conference delegates decided to allocate portions of this band to BSS-Sound (1452-1492 MHz) and MSS (1492-1525 MHz—for Region 2 only). The United States was forced to insert a footnote (722B) to protect aeronautical telemetry interests. The strength of the wording of the footnote, however, was the subject of hot debate between private sector interests, who wanted to leave open the possibility of future (MSS) uses of the band, and Defense Department/NTIA interests, who believed that strong language was needed to keep unwanted services out. Following the original U.S. position, the delegation drafted language that was very strict, and sent it to the U.S. home team for comment and approval. The home team concluded that the language was too uncompromising and sent draft language back to the delegation that NTIA/Defense Department believed was not strong enough. In the end, the delegation stuck to the original U.S. position, and the harsher version of the footnote became the official footnote. Opinions differ as to what the real effect of this wording will be.

In this case, the original delegation instructions for the issue were followed to the letter, a decision made by the delegation itself in spite of new instructions from the home team. Several questions arise: Does the delegation or the head of delegation have the authority to ignore the home team's instructions? Who made the policy decision that the footnote should be so harsh? Was adequate consideration given to private sector concerns? Is the private sector at a disadvantage once WARCs start in terms of influencing subsequent policy decisions?

# Appendix A: Structure and Proceedings of WARC-92[1]

The supreme body of WARC-92 was the plenary, in which all countries participated. The plenary was chaired by the Honorable Jose Barrionuevo Peña, member of the Spanish Parliment.[2] WARC-92 delegates selected five vice-chairs to assist him, including Ambassador Jan Baran, the head of the U.S. delegation.[3] Agreements were Finalized at the plenary sessions, most of which took place in the last several days of the conference.

## Structure of the Conference

The work of WARC-92 was functionally divided among seven committees, With the exception of Committee 1, each of the committees had a single chair and vice-chair.

*Committee 1:* The Steering Committee was composed of the chair and vice-chair of the conference and the chair and vice-chair of the other committees listed below. It coordinated the meetings and other activities of WARC-92.

*Committee 2:* The Credentials Committee was charged with verifying the diplomatic credentials of the delegations present at WARC-92.

*Committee 3:* The Budget Control Committee had two purposes, overseeing conference expenditures and identifying the financial implications of WARC-92 decisions.

*Committee 4:* The Frequency Allocations Committee was the focus of much of the work at WARC-92. All of the decisions on how to allocate the spectrum were made during the deliberations of this committee and its subcommittees. Committee 4 divided its work into three subcommittees: working groups A, B, and C. Working Group 4A considered allocation issues in the frequencies below 137 MHz, specifically high-frequency broadcasting. Working Group 4B considered allocations for services between 137 MHz and 3 GHz. Among the topics included in 4B discussion were most of the ''hot' issues—mobile satellite services, including big and little low-Earth orbiting satellites (LEOS), Future Public Land Mobile Telecommunication Systems (FPLMTS), Broadcasting-Satellite Service-Sound (BSS-Sound), and some of the space services. Working Group 4C considered allocations above 3 GHz, including space services, high-definition television (HDTV), and general satellite service. In addition to these working groups, Committee 4 also assigned specific tasks

[1] The following section is based on International Telecommunication Union, "Inauguration of WARC-92," *Telecommunication Journal*, vol. 59, No. 3, 1992, and U.S. Department of State, *United States Delegation Report,' 1992 World Administrative Radio Conference,* publication 9988, July 1992, Annex F.

[2] When ITU conferences are not held in Geneva, the headquarters of ITU, the chairman of a WARC is traditionally provided by the country hosting the conference.

[3] The other vice-chairs were from the Russian Federation, Cote d'Ivoire, China, and Norway.

to a number of other smaller groups, some of which are described below.

*Committee 5: The* Regulatory Committee was the other most important committee at WARC-92. It considered the regulatory changes and procedures resulting from the decisions made in Committee 4, and debated definitions for new services. The committee also split its work into working groups—5A, 5B, and 5C- and a number of subworking groups to address specific regulatory issues.

*Committee 6: The* Editorial Committee "aligned" the texts developed in the Allocations and Regulatory Committees-ensuring that the texts contained the same meanings in the official languages of the International Telecommunication Union (ITU)--French, English, and Spanish. This was an important committee because countries could try to "align" the texts to their best advantage-sometimes trying to make changes that altered the substance of the agreements, especially if they had earlier "lost" on an issue in committees 4 and 5.

A Technical Working Group to the Plenary was also established in order to consider complex technical issues that required in-depth analysis or study and that could not be resolved in the work of Committees 4 and/or 5. In addition to providing technical advice to the conference, the Working Group to the Plenary also had its own set of issues to consider, including making recommendations for future conferences to address meteorological and Earth-exploration satellite services, new space services in bands above 20 GHz, and meteorological aids services in bands below 1 GHz.

With so many different groups covering so many different topics, overlapping meetings were unavoidable. In many cases, the deliberations of Committees 4 and 5 went on simultaneously. For the United States, with 71 delegates and support staff, covering all important meetings was not all that difficult. For smaller nations, however, who sent only one or two delegates to the conference, attendance at all relevant meetings was impossible. These countries tended to split their time between the various working, ad hoc, and drafting groups of Committees 4 and 5.

## Negotiation and Decisionmaking

The work of the conference was hierarchically structured. In Committee 4, allocations issues were divided among the appropriate working groups (listed above). Once these groups started their discussions, some issues were decided relatively easily and early in the conference. Other issues, however, were more difficult. The most contentious issues, includingMobile-Satellite Service (MSS), Broadcasting-Satellite Service-Sound (BSS-Sound), and FPLMTS, were handed down to smaller working groups, which usually consisted only of the major parties involved in the debate. Often the membership in these subgroups was balanced to ensure fair geographic representation among the ITU's three regions.

The process of formalizing agreements followed this hierarchy in reverse order. Each small drafting or ad hoc group would come to an agreement and then report its findings to its parent group or committee. In cases where agreement was not possible, the topic was "bumped up" to the parent committee for discussion and resolution. In this way, issues worked their way back up the conference structure. After final texts had been agreed to in Committees 4 and 5, these documents were sent to Committee 6 to be aligned. From Committee 6, draft agreements finally reached the plenary level, where the drafts were read through several times for final agreement, each time refining wording further and resolving any remaining issues or questions.

By the end of the conference, most issues had been resolved in the committees or their subcommittees. However several issues—MSS, including big LEOS, BSS-Sound and FPLMTS-had not been resolved. They were brought to the floor of the full Committee 4 and eventually to the plenary for final resolution,

## Ad Hoc and Drafting Groups

In addition to the above committees, ad hoc groups and drafting groups were established as needed throughout the conference. Some of the more notable groups are listed below.

COMMITTEE 4

Ad Hoc **Group 1**—To harmonize allocation options for the general-satellite service.

Ad Hoc Group 3-To identify from options resulting from the work of Drafting Group 1 to Working Group 4C a single allocation option to put forward to Committee 4 that meets the requirements of the proposing administrations and addresses the concerns of affected administrations, taking into account the Report of the Chairman of Working Group 4C to the Chairman of Committee 4 (Dec. 207) with respect to the general-satellite service.

Drafting Group 4B1-Space research and operation service 1 GHz, mobile and mobile-satellite service below 1 GHz.

Drafting Group 4B2--Consolidation of all proposals for the mobile-satellite service between 1 and 3 GHz.

**Drafting Group 4B3-Consolidation** of all proposals for the broadcasting-satellite service (sound).

**Drafting Group 4B4---Consolidation** of all proposals on regional and worldwide mobile communications including FPLMTS.

Ad Hoc Group 4B5--To harmonize proposals for the space operations, space research, and Earth exploration-satellite services in the bands 2025-2110 MHz and 2200-2290 MHz.

Drafting Group to Ad Hoc 4B5

To harmonize the texts of Resolutions concerning the space research, space operation and Earth exploration-satellite services at 2 GHz.

Drafting Group 4B6--Aeronautical public correspondence.

AD Hoc Group 4B7—Consideration of the mobile-satellite service in the upper and lower L-bands.

Ad Hoc **Group to** 4B-Consideration of new mobile satellite service allocations above 1 GHz and below 3 GHz.

Ad Hoc to Subworking Group 4C2-To consider the issue of feeder links for the broadcasting-satellite service for wide-band HDTV.

Drafting Group 4C1—To consider all proposals for allocations to the space research, Earth exploration-satellite and inter-satellite services above 25.25 GHz.

Ad Hoc Group 4C2-Consideration of proposals for an allocation to the fixed-satellite service in the band 14.5 -14.8 GHz.

Drafting Group-Ad Hoc 4C2

Consideration of conditions under which the fixed-satellite service could operate coprimary with the radiolocation service.

Ad Hoc Group 4C3-To consider proposals for allocations to the general-satellite service.

Drafting Group-To integrate proposals from five administrations to establish frequency bands for use by space-to-Earth 30 GHz Beacon in the fixed-satellite service for purposes of uplink power control.

COMMITTEE 5

Ad Hoc 3 to Committee 5-To monitor progress of work in the working group to the plenary and decisions of Committee 4 and to incorporate such changes in consolidated texts of changes to Articles 27,28 and 29.

Drafting Group 5B-Consideration of possible ways of eliminating the differences of interpretation among the English, French and Spanish texts.

Drafting Group 5C3--Redraft of text from the draft resolution relating to terrestrial digital broadcasting.

**TECHNICAL WORKING GROUP OF THE PLENARY**

**Drafting Group** l—To consider new resolutions or recommendations regarding primary allocations for meteorological-satellite and Earth exploration-satellite services in the 401-403 MHz band.

Drafting Group 4-To consider proposals concerning modification to Resolution 703.

Drafting Group 5-To consider technical issues relating to proposals concerning modification of the definition of ‘geostationary-satellite orbit.”

Ad Hoc 6-To examine the necessary technical parameters required to protect service allocations made by Committee 4, particularly with respect to Articles 27,28,29.

# Appendix B: International Observers at WARC-92[1]

Asia-Pacific Broadcasting Union (ABU)
Asia-Pacific Telecommunity (APT)
Arab Satellite Communications Organization (ARAB SAT)
Arab States Broadcasting Union (ASBU)
Asociacion Internacional de Radiodifusion (AIR)
Caribbean Telecommunications Union (CTU)
Comite International Radio Maritime (CIRM)
Commission of the European Communities (CE)
Conference of European Postal and Telecommunications Administration (CEPT)
Cooperation in Space-Search and Rescue Satellite (COSPAS-SARSAT)
European Broadcasting Union (UER/EBU)
European Meteorological Satellite Systems (EUMETSAT)
European Space Agency (ESA)
European Telecommunications Satellite Organization (EUTELSAT)
Gulf Cooperation Council (GCC)
International Air Transport Association (IATA)
International Amateur Radio Union (IARU)
International chamber of Shipping (ICS)
International Civil Aviation Organization (ICAO)
International Maritime Organization (IMO)
International Maritime Satellite Organization (INMARSAT)
International Organization of Space Communications (INTERSPUTNIK)
International Telecommunications Satellite Organization (INTELSAT)
International Transport Workers' Federation (ITF)
Inter-Union Commission on Frequency Allocations for Radio Astronomy and Space Science (IUCAF)
Organization Meterologica Mundial [World Meteorological Organization-WMO] (OMM)
Pan African Telecommunications Union (PATU)
Societe Internationale de Telecommunications Aeronautique (SITA)
United Nations (UN)
Union des Radio-Televisions Nationales Africaines [African National Radio-Television Union] (URTNA)

[1] Based on U.S. Department of State, *United States Delegation Report: 1992 World Administrative Radio Conference,* publication 9988, July 1992, Annex E.

# Appendix C: Selected WARC-92 Resolutions and Recommendations

| Resolution/Recommendation Number[1] | Topic |
|---|---|
| Resolution 112 (COM 4/1) | Coordination and technical sharing parameters for the Fixed-Satellite Service at 13.75-14 Hz. |
| Resolution 211 (COM 4/2) | Use of the bands 2025-2110 MHz and 2200-2290 MHz by the Mobile Service. |
| Resolution 711 (COM 4/3) | Convening a WARC to reallocate frequencies supporting space missions from the 2 GHz band to frequencies above 20 GHz. |
| Resolution 212 (COM 4/4) | Implementation of Future Public Land Mobile Telecommunication Systems (FPLMTS); invites International Radio Consultative Committee (CCIR) and International Telegraph and Telephone Consultative Committee (CCITT) to study and develop administrative plans. |
| Resolution 113 (COM 4/6) | Invites a CCIR study on adjustments to the Fixed Service as a consequence of changes to the frequency allocations within the range 1-3 GHz. |
| Resolution 114 (COM 4/7) | Convening a WARC to address space issues not dealt with at WARC-92, particularly Earth Exploration-Satellite Service used for monitoring environmental data. |
| Resolution 523 (COM 4/8) | Convening of a WARC for the planning of the High-Frequency Broadcasting Service; also, the additional bands are not to be used until a planning process has been completed. |
| Resolution 518 (COM 4/W) | Convening of a WARC not later than 1998 to plan the Broadcasting-Satellite Service-Sound (BSS-Sound) and development of procedures for the coordinated use of the complementary terrestrial service. |
| Resolution 213 (COM 4/X) | Invites the CCIR to conduct sharing studies concerning the use of the bands 1492-1525 MHz and 1675-1710 MHz in Region 2 by the Mobile-Satellite Service. |

[1] In this appendix, both the provisional and final numbers of the resolutions and recommendations are noted. The numbers listed in parentheses arc the provisional designation adopted and used at WARC-92.

| Resolution/Recommendation Number[1] | Topic |
|---|---|
| Resolution 411 (COM **5/1)** | **Implementation** of the new provisions applicable in the frequency bands allocated exclusively to the Aeronautical-Mobile (Off Route) Service between 3025 kHz and 18030 kHz. |
| Resolution 412 (COM 5/2) | Procedures for transfer of frequency assignments of aeronautical stations operating in the frequency bands allocated exclusively to the Aeronautical-Mobile (Off Route) Service between 3025 kHz and 18030 kHz. |
| Resolution 524 (COM 5/3) | Convening of a WARC to review and improve the region 1 and 3 Broadcasting-Satellite Service (BSS) plans in frequency range 11.7 -12.5 GHz (Region 1) and 11.7 -12.2 GHz (Region 2). |
| Resolution 338 (COM 5/4) | Provisional application of article 56 to ensure harmonization with the International convention for the Safety of Life at Sea (SOLAS) as revised in 1988. |
| Resolution 525 (COM 5/5) | Introduction of BSS high-definition television (HDTV) systems in the band 21.4-22.0 GHz in Regions 1 and 3. |
| Resolution 526 (COM 5/6) | Procedures to ensure flexibility in the Broadcasting-Satellite Service-HDTV and associated feeder links. |
| Resolution 21 (COM 5/7) | Implementation of changes in frequency allocations between 5900 kHz and 19020 kHz. |
| Resolution 46 (COM 5/8) | **Interim** procedures for the coordination and notification of frequency assignments of non-geostationary satellite networks, in certain space services, and other services allocated in the band. |
| Resolution 22 (COM 5/9) | Asks future world development conference to develop priorities so that the International Telecommunication Union (ITU) can provide support to developing countries in implementing the decisions of WARC-92. |
| Resolution 527 (COM 5/10) | Convening of a WARC to address VHF terrestrial digital audio broadcasting (DAB) for Region 1 and interested Region 3 countries. |
| Resolution 70 (COM 5/1 1) | Invites ITU to carry out technical, legal and operational studies leading to standards governing operation of low-Earth orbiting satellite (LEOS) systems. |
| Resolution 710 (GT-PLEN/1) | Examination of the meteorological-satellite and Earth exploration-satellite allocations in the bands 401402 MHz and 402-403 MHz with the intent of raising the allocation status to primary. |
| Resolution 522 (GT-PLEN/2) | Further CCIR study concerning BSS-Sound with the view to developing regulatory provisions for sharing with other services in the same frequency band. |
| Resolution 94 (GT-PLEN/3) | Reviews of resolutions and recommendations of previous WARCs to continue. |

| Resolution/Recommendation Number[1] | Topic |
|---|---|
| Resolution 93 (GT-PLEN/4) | Review of certain resolutions and recommendations of WARC-79, 1983 WARC for the Mobile Services, 1987 WARC on high frequency broadcasting (HFBC), 1987 WARC for the Mobile Services, and the 1988 WARC on the Use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilizing It. |
| Resolution 410 (GT-PLEN/AH-1) | Development of an arrangement for the allotment of frequencies for the Aeronautical-Mobile (Off Route) Service in exclusive bands between 3025 kHz and 18030 kHz. |
| Recommendation 519 (COM 4/A) | Recommends that a future WARC advance the date for implementation of single-sideband emissions in the high-frequency (HF) broadcasting bands. |
| Recommendation 520 (COM 4/B) | Elimination of HF broadcasting on frequencies outside the HF bands allocated to broadcasting service. |
| Recommendation 718 (COM 4/C) | Asks ITU to hold a future WARC to consider the possibility of aligning amateur and broadcast allocations around 7 MHz so as to provide a worldwide allocation. |
| Recommendation 719 (COM 4/D) | Asks CCIR to carry out studies on the technical characteristics and sharing criteria of multiservice satellite networks using geostationary orbit. |
| Recommendation 621 (GT-PLEN/A) | Asks CCIR to study characteristics and requirements of wind profiler radars with a view to allocating appropriate frequency bands around 50,400, and 1000 MHz; also invites Administrative Council to include question of appropriate frequency allocations for operational use of wind profiler radars. |
| Recommendation 717 (GT-PLEN/B) | Recommends that the CCIR study sharing criteria in frequency bands shared by the Mobile-Satellite Service with the Fixed, Mobile and other radio services. |

SOURCE: U.S. Department of State, *United States Delegation Report; 1992 World Administrative Radio Conference, publication 9988,* July 1992.

# Appendix D: Acronyms and Glossary of Terms

Ad Hoc 206: A subcommittee of the IRAC that was established to coordinate Federal agencies' preparations for WARC-92. Ad Hoc 206 was reconvened in order to consider how to implement WARC-92 decisions.

Allocation: The designation of a band of frequencies to a specific radio service or services. Allocations are made internationally at World Administrative Radio Conferences and are incorporated into the international Table of Frequency Allocations. International allocations are usually, but not always, incorporated into domestic frequency tables.

Analog: In analog radiocommunication, information is transmitted by modulating a continuously varying electronic signal, such as a radio carrier wave. Voice and video messages originate in analog form since sound and light are wavelike functions. In order to send these analog signals over digital media, such as fiber optics or digital radio, they must be converted into a digital format.

APC: Aeronautical public correspondence. APC refers to radiocommunication services that allow airline passengers to place telephone calls while in flight. Also known as air-to-ground (ATG) communication.

Assignment: The granting by a government of the right to use a specific frequency (or group of frequencies) to a specific user or station. Each television station, for example, is assigned a small group of frequencies that correspond to a specific channel number.

Bandwidth: The total range of frequencies required to transmit a radio signal without undue distortion is its bandwidth. It is measured in hertz. The bandwidth of a radio signal is determined by the amount of information in the signal being sent. More complex signals contain more information, and hence require wider bandwidths. An AM radio signal, for example takes 10 kHz, while an FM signal requires 200 kHz, and a television signal takes up 6 MHz. The bandwidth required by a television channel is 600 times greater than that of an AM radio channel.

BSS: Broadcasting-Satellite Service. An ITT-J-defined service that refers to the delivery of information or programming from satellites directly to user receivers. The BSS includes new systems planned to deliver high-definition television services (BSS-HDTV) and audio services (BSS-Sound).

CCIR: International Radio Consultative Committee. An organ of the ITU that studies and makes recommendations on the technical standards for radiocommunication.

CCITT: International Telegraph and Telephone Consultative Committee. An organ of the ITU that studies and makes recommendations on the technical and operational standards for international wireline communications. CCITT also addresses international tariff issues.

CDMA: Code division multiple access. CDMA is a recently developed radiocommunication format that uses digital technology and spread spectrum transmission to send information. Each radio signal is assigned its own unique code and is then spread over a range of frequencies for transmission. At the receiving end the receiver reconstructs the original signal by following the code.

CEPT: Conference of European Postal and Telecommunications Administrations. Established in 1959, CEPT consists of 33 European telecommunications administrations. It acts to coordinate and reconcile regional telecommunications policy.

CIP: Bureau of International Communications and Information Policy. Bureau of the State Department that represents the United States in international telecommunications negotiations and conferences. CIP's bureau status was recently revoked and the bureau placed under the Bureau of Economic and Business Affairs.

CITEL: The Inter-American Telecommunications Conference. A specialized conference of the Organization of American States (OAS) that deals with both radio and wireline communications. CITEL is a permanent, ongoing series of conferences that has 35 members from North and South America and the Caribbean.

CT2: Cordless telephone **2.** Personal communications system that allows users to make calls, but not receive them. CT2 systems have been demonstrated in Europe, but only one system has been demonstrated in the United States.

DAB: Digital audio broadcasting. DAB refers to the transmission of audio broadcasts in digital form as opposed to today's (AM or FM) analog form. DAB promises compact disc quality sound over the air. Many formats are being developed, and transmission is possible via terrestrial transmitters, satellites, or hybrid systems.

DBS: Direct broadcast satellite. Medium- to high-power satellites that are designed to transmit programming directly to small satellite receiver dishes at users' homes. No DBS systems are operating in the United States, although several systems are planned.

Digital: In digital communication, the continuously varying signals of images and voice are converted to discrete numbers represented in binary form by O's and 1's. These binary digits, orbits, can then be sent as a series of "on'' /''off' pulses or can be modulated onto a carrier wave by varying the phase, frequency, or amplitude according to whether the signal is a 1 or a O.

Downlink: In satellite communications, the signal that travels from the satellite down to the receivers on **Earth.** The direction the downlink signal travels is also called space-to Earth. See uplink.

FCC: Federal Communications Commission. An independent Federal agency that regulates private and all nonfederal government use of the radio frequency spectrum. The FCC is also responsible for regulating most other forms of communication, including broadcast and cable television, and some telephone services.

Fixed Service: An ITU-defined radiocommunication service between specified, fixed points. Also known colloquially as point-to-point communication.

FPLMTS: Future public land mobile telecommunication systems. FPLMTS is a concept now being developed in the CCIR for future mobile services, including PCS.

GSM: Global System for Mobile communications, formerly, Groupe Special Mobile. A digital mobile communications standard now being deployed across Europe that is intended to replace existing analog cellular telephone services. GSM will allow systems in different countries to interoperate, permitting consumers to use their cellular phones anywhere in Europe.

HDTV: High-definiton television. Refers to future generations of television that will have higher picture resolution, a wider aspect ratio, and digital quality sound.

Hertz (Hz): Cycles per second. Radio frequencies are described in multiples of hertz:

kHz, kilohertz: thousand cycles per second;
MHz, megahertz: million cycles per second;
GHz, gigahertz: billion cycles per second.

HF: High frequency. Refers to radio frequencies in the range 3-30 MHz. These frequencies are used by international broadcasting services including Voice of America, religious broadcasters, and fixed services such as the point-to-point communication systems used by developing countries.

HFBC: High Frequency Broadcasting Conference. Specialized world radio conferences were held in 1984 and 1987.

HLC: High Level Committee. The HLC was established by the Administrative Council of the ITU, in response to instructions from the Nice Plenipotentiary, in November 1989 in order to review the structure and functions of the ITU. The study included organization, finance, staff, and coordina-

tion. The group finished its work in June 1991, and its recommendations were considered at the Special Plenipotentiary Conference in December 1992.

IAC: Industry Advisory Committee. The FCC set up the IAC to coordinate and focus private sector input for the WARC-92 preparation process. It consisted of 35 representatives from the private sector and was cochaired by FCC Commissioner Sherrie Marshall. It issued its final report in April 1991.

IFRB: International Frequency Registration Board. The organ of the ITU responsible for maintaining the list of radio frequencies used worldwide. It also conducts technical and planning studies for the ITU. According to changes agreed to at the ITU's December 1992 Special Plenipotentiary, the IFRB will be replaced by a 9-member part-time board.

IRAC: Interdepartment Radio Advisory Committee. Established in 1922 and now located in the Department of Commerce, the IRAC consists of approximately 20 to 25 representatives from the various Federal Government agencies involved in or using radio frequencies. The IRAC advises NTIA on matters relating to Federal Government use of the radio frequency spectrum.

ITU: International Telecommunication Union. The ITU is a specialized agency of the United Nations responsible for international regulation of telecommunications services of all kinds, including telegraph, telephone, and radio.

LEOS: Low-Earth orbiting satellite. LEO satellites are smaller and cheaper to design, build, and launch than traditional geosynchronous satellites. Networks of these small satellites are being planned that will provide data ("little" LEOS) and voice ("big" LEOS) services to portable receivers all over the world.

Modulation: The process of encoding information onto a radio wave by varying one of its basic characteristics-amplitude, frequency, or phase-in relation to an input signal such as speech, music, or television. The input signal, which contains the information to be transmitted, is called the modulating or baseband signal. The radio wave that carries the information is called the carrier wave, The radio wave that results from the combination of these two waves is called a modulated carrier. Two of the most common types of modulation are amplitude modulation (AM) and frequency modulation (FM).

Mobile Service: An ITU-defined service in which communication services are provided to mobile users through terrestrially-based systems (large towers). Cellular telephone systems provide mobile services. PCS and FPLMTS would also be classified under the mobile service. See Mobile-Satellite Service.

MSS: Mobile-Satellite Service. MSS is an ITU-defined service in which satellites are used to deliver communications services (voice or data usually, one- or two-way) to mobile users such as cars, trucks, ships, and planes. It is a generic term that encompasses several types of mobile services delivered by satellite, including Maritime MSS (MMSS), Aeronautical MSS (AMSS), and Land MSS (LMSS).

NTIA: National Telecommunications and Information Administration. The agency in the Department of Commerce that oversees all Federal Government use of the radio frequency spectrum. NTIA also serves as the President's adviser on all telecommunication matters,

OIA: Office of International Affairs. The office in NTIA responsible for international aspects of telecommunications, including preparation and participation in international communications negotiations and conferences.

OIC: Office of International Communications. Established by the FCC in January 1990 to coordinate and serve as the focal point for international activities in the FCC.

OSM: Office of Spectrum Management. The office of NTIA responsible for day-to-day management of Federal Government spectrum use. Also provides technical assistance to OIA in preparation for international negotiations and conferences.

PCS: Personal communication network/service. Although the term is not yet clear, PCS seems to be emerging as an umbrella term that refers to any of the many mobile services (voice and data) designed to serve individuals wherever they are (walking, driving, flying).

Primary status: Radio services with primary status have full rights to use any or all of the radio frequencies that have been allocated to them, unless modified by a footnote to the international Table of Frequency Allocations. Such a footnote can specify countries in which a service may not operate or can

specify technical constraints such as maximum levels of power allowed. When two primary services share the same frequencies, they must coordinate their use to ensure that interference is minimized. See secondary status.

PTT: Post, telegraph, and telephone administration. PTTs are the government agencies that have been the sole providers of telecommunication services in many foreign countries for years. Today, their power and monopolies are declining in the face of liberalization and privatization.

Radio astronomy: The study of the stars and planets using radio waves. Radio waves allow scientists to determine the composition of planets and their atmospheres. Because radio waves received from space are very weak, radio astronomy receivers must be extremely sensitive.

RDSS: Radiodetermination-Satellite Service. RDSS is an ITU-designated service in which satellites provide location information to ships, planes, vehicles, and even individuals such as hikers.

Secondary status: Secondary radio services are not allowed to cause interference to primary services and cannot claim any protection from interference from primary services. They must accept interference from a primary service if it occurs. See primary status.

**Spectrum: The spectrum of an individual radio signal** is the range of frequencies it uses, The width of the spectrum is also called the bandwidth of the signal. More broadly, the radio frequency spectrum consists of all the radio frequencies that are used for radiocommunications.

SSB: Single sideband. A method of transmitting radio signals in which only one sideband is transmitted and, often, the carrier is transmitted at reduced power.

Uplink: In satellite communications, the signal that travels from an Earth transmitting station up to the satellite. The direction the uplink signal travels is also known as Earth-to-space. See downlink.

WARC: World Administrative Radio Conference. WARCS are the primary forum for distributing the frequencies of the spectrum to the various radiocommunication services, They can address all radio services (a general WARC) or only specific portions of the spectrum (specialized WARC). The Final Acts of a WARC have international treaty status and must be signed by member governments. The allocations decided on at a WARC usually are incorporated into domestic tables of allocations. WARCs have now been renamed by the ITU, and will be called world radiocommunication conferences in the future.

# Appendix E: Negotiated Rulemaking: An Alternative to Traditional Rulemaking

## Background

For several years, the FCC has been searching for a better way to develop new service rules and license new service providers. This search is, in part, the result of the rash of litigation that often surrounds FCC decisions, and the FCC's desire to avoid lengthy court battles in order to speed the introduction of (new) services to the public. Several options have been discussed and tried including lotteries, spectrum auctioning, a consortium, and now negotiated rulemaking. This is the first time such an approach has been tried by the FCC, and observers and proponents of other new services are watching the process closely. If the process succeeds for little LEOS, the FCC expects to use it as a model in other proceedings-with potentially widespread effects on the traditional approach to rulemaking at the FCC.[1]

In order to speed the development of the rules and regulations governing the new little LEOS systems, the FCC established an Advisory Committee under the Federal Advisory Committee Act (FACA)[2] and the Negotiated Rulemaking Act[3] to assist in the development of the technical and service rules and regulations that will govern the provision of mobile (and fixed) services provided by LEOS systems operating in frequencies below 1 GHz. Pursuant to the requirements of the FACA, the FCC issued a public notice of its intention to form an advisory committee on little LEOS in April 1992,[4] Numerous parties responded to the notice, including Orbcomm, Starsys, Volunteers in Technical Assistance (VITA), who submitted jointly-filed comments that outlined their proposals for technical and service rules.[5] These comments were intended to form the basis for the FCC Notice of Proposed Rulemaking (NPRM) on little LEOS service rules, thereby eliminating the need for the Advisory Committee altogether. The FCC did not accept this approach, and proceeded to form the Advisory Committee, It met for the first time on August 10, 1992, at which time the charter of the group and a work plan were discussed.

## Participants

In addition to the companies that have filed applications to provide little LEOS services-VITA, Starsys, Orbcomm, and Leosat[6]-representatives from several

[1] The FCC, in fact, has begun a negotiated rulemaking for LEOS systems operating above 1 GHz. Federal Communications Commission, "MSS Above 1 GHz Negotiated Rulemaking Committee," Public Notice, DA 92-1691, released Dec. 15, 1992.

[2] 5 USC App. 2 (Dec. 21, 1982).

[3] Negotiated Rulemaking Act of 1990 (NRA), Public Law 101-648, Nov. 28, 1990.

[4] Federal Communications Commission ''FCC Asks for Comments Regarding the Establishment of an Advisory Committee to Negotiate Proposed Regulations, " Public Notice, DA 92-443, released Apr. 16, 1992.

[5] See Jointly Filed Comments of ORBCOMM, STARSYS, and VITA, ''In the Matter of Establishment of an Advisory Committee to Negotiate Proposed Regulations for Low-Earth Orbit Satellite Services Operating Below I GHz,'' CC Docket No. 92-76, May 18, 1992, and Jointly Filed Supplemental Comments of Orbcomm, Starsys, and VITA in above proceeding, Aug 7, 1992.

[6] Leosat's application was dismissed by the FCC on procedural grounds, Leosat filed for a reconsideration of this dismissal, but that appeal was denied. It was allowed to sit on the Advisory Committee despite objections by Orbcomm.

government agencies and the aeronautical community participated in the work of the committee.[7] Government representatives were primarily interested in ensuring that their existing use of the frequencies in and adjacent to the bands to be used by little LEOS would be adequately protected. The Air Force, for example, is planning an addition to its meteorological satellite system that could be subject to interference from the new LEOS systems.

## Charter and Work Program

The official charter of the Advisory Committee states that the task of the Committee was to "gather and discuss information necessary to form recommendations to the FCC for the regulation, licensing and coordination of little LEO satellite services. This information will be used by the FCC in conjunction with its separate proceeding on the frequency allocations for little LEOS[9], and will form the basis for an NPRM that will outline technical and service rules for new little LEOS services. In order to accomplish this work in a timely manner, an informal working group was formed to look at the specific issues outlined in the work plan for the committee. An editorial working group was formed to develop the language for the Committee's final report to the FCC.

The FCC's general goal, as outlined in the work program for the committee, was to find ways to facilitate sharing-not only among the three proposed systems, but also between them and existing (terrestrial and space) systems using the proposed (and adjacent) frequencies, between U.S. and international users of the frequencies, and between present and future users of the bands, including future additional LEOS systems.

In the course of its deliberations, the committee addressed the following issues, among others:

- How to license multiple operators;
- The impacts of the footnotes adopted at WARC-92 on little LEOS services;
- Sharing considerations, as noted above;
- Which modulation (code division multiple access, time division multiple access, or frequency division multiple access) method should be employed;
- The need for separate rules for nonprofit providers such as VITA;
- Coordination mechanisms with other services, including services sharing the same bands and services using adjacent bands that could be subject to interference from little LEOS operations.

The committee finished its work as scheduled and submitted its final report to the FCC on September 18, 1992.

### DISCUSSION

The work of the committee was contentious for several reasons. First, the frequencies in question are to be used by both the Federal Government and the private sector, and some of these frequencies were being opened up for the first time to the private sector. In the United States, the 148-149.9 MHz band, for example, was previously reserved for military fixed and mobile communications.

Second, the international ramifications of the decisions made in the committee and the FCC were significant, The United States will be the first country to operate commercial LEOS systems in these bands, and other countries are apprehensive that what is decided in the United States will become the &facto

[7] The full membership of the committee consisted of: ARINC, Inc., Department of the Air Force, Department of the Army, Department of the Navy, Federal Aviation Administration, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration Leosat, Orbcomm, Starsys, and VITA. The FCC supplied the facilitator and the designated Federal representative for the group.

[8] Federal Communications Commission, ' 'Charter for the Below 1 GHz LEO Negotiated Rulemaking Committee, ' Document LEOAC- 13, Aug. 10, 1992, p. 1.

[9] Federal Communications Commission, "Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum to the Fixed-Satellite Service and the Mobile-Satellite Service for Low-Earth Orbit Satellites," ET Docket No. 91-280, FCC 91-305, released Oct. 18, 1991.

rules for little LEOS operation all over the world.[10] The FCC was keenly aware of these concerns.

Third, the timeline for the process was ambitious. The FCC wanted to move the process along quickly in order to let the prospective companies get their services up and running as soon as possible--a strategy that would allow U.S. companies to bring their services into operation ahead of any foreign competition.[11] This short timeline was also instituted so that a negotiated rulemaking on big LEOS could begin as soon as possible--conducting two negotiated rulemakings simultaneously was not possible due to limitations on FCC staff time. As a result, the committee was given only 37 days to do its work. Meetings were held every week, supplemented by work conducted in the informal working group and the editorial group.

Finally, in an attempt to speed the process,[12] and some have argued, circumvent potential dissent, the three main little LEOS system proponents met informally and devised a set of rules and sharing arrangements that they submitted to the FCC with the hope of having them adopted by the FCC.[13] The FCC chose not to adopt them whole, but to include them as inputs to the work of the Advisory Committee. Leosat, a little LEOS proponent whose application was dismissed by the FCC, was not part of those informal meetings and accused the others of trying to stifle competition.

## Results

The final report represented, as much as possible, a consensus of views reached in the course of the month-long deliberations of the committee and its informal working groups. However, disagreements on several matters were not resolved. To accommodate additional views on these matters, the report includes separate statements from several of the participants. The committee submitted its final report to the chief of the FCC's Common Carrier Bureau for consideration in the FCC preparation of its formal NPRM on little LEOS service rules. The NPRM was adopted in January 1993.

One issue that remains unclear is how future LEOS systems will be accommodated. The FCC has maintained a commitment to promoting competition in little LEOS services, and has said that it would like to see at least three competitors and maybe more offering such services. A crucial question not determined in the negotiated rulemaking process was how many entrants can be accommodated. The private sector participants in the process, of course, would like to limit entry by potential future competitors and have said that trying to accommodate unspecified future needs would be impossible.

Another unresolved issue, and the subject of heated debate during the course of the committee's work centered on the question of which modulation scheme is best suited for little LEOS applications. Orbcomm and VITA have indicated that they will use a frequency division multiple access system, while Starsys and Leosat have proposed code division multiple access systems.

---

10 See, for example, the comments of Michel Carpentier, Director General (telecommunications) for the European Community Commission: ''It is a matter of some importance to the commission to ensure that the initial LEO systems are introduced in such a manner as not to prejudice competition, and in particular, to ensure that future systems can operate within the constraints of the existing allocation. '' Quoted in "U.S. Accepts EC Commission Request for Informal Talks. . ." *Telecommunications Reports,* July 27, 1992, p. 15,

11 Smolsat, a Russian LEOS system, is already partly operational.

12 Speeding Up the process helps the LEOS providers in at least two ways. First, the delay costs them money. The quicker these systems can be licensed and begin operations, the faster they can begin making money and producing revenue. In the meantime, all the companies still have costs (salaries) that must be paid. Second, a quicker start keeps actual and potential investors interested-the longer to returns on investment, the less these systems are likely to attract new investors and the more discontented existing investors become. They are less likely to keep putting money in for salaries when the potential returns keep slipping in time. This is an important consideration in an era where private capital for expensive and somewhat risky ventures is tight.

13 See Jointly Filed Comments of Orbcomm, Starsys, and VITA, ''In the Matter of Establishment of an Advisory Committee to Negotiate Proposed Regulations for Low-Earth Orbit Satellite Services Operating Below 1 GHz,'' op. cit., footnote 5, and Jointly Filed Supplemental Comments of Orbcomm, Starsys, and VITA in same proceeding, Aug. 7, 1992.

# Index


Ad Hoc 206, 154, 158
Administrative Council (of the ITU), 15, 147, 161
Advanced communications technology satellite (ACTS), 140
Aeronautical-mobile satellite service (AMSS), 89-90
Aeronautical public correspondence (APC), 5,25, 119, 132-134, 146
Aeronautical telemetry, 16,53,65,69,71,75-76, 144
AfriSpace, 71
Allocations table. See international Table of Frequency Allocations
American Mobile Radio Corporation, 68
American Mobile Satellite Corporation (AMSC), 87-88,92,95,96-97, 116
Ardis, 107
Aries, 114
Association of South East Asian Nations (ASEAN), 23

Baran, Ambassador Jan, 10,21,28,103,120,156, 163, 166, 167, 169
BBC (British Broadcasting Corporation), 55
Berrada, Abderrazak, 17
Broadcasting-Satellite Service-high-definition television (BSS-HDTV), 5, 11, 25, 128-132, 146
Broadcasting-Satellite Service-Sound (BSS-Sound), 4, 11, 15, 16,53, 63-64,64-76, 144, 146, 161
Bureau of Communications and Information Policy (CIP), 46, 48, 147, 155-157. See *also* Department of State
Bureau of Telecommunications Development (of the ITU), 16

Cable Television Consumer Protection and Competition Act of 1992, 152
Canada
  and APC, 133
  and BSS-Sound, 70, 76, 144
  paging operations in, 105
CaribSpace, 71
CCIR. See International Radio Consultative Committee
CCITT. See International Telegraph and Telephone Consultative Committee
CDMA (code division multiple access), 116,121,122, 124
Cellular telephone, 77,85, 125, 137
  digital standard for, 34, 85-86
Cellular Telecommunications Industry Association, 77
Celsat, 117
Centre National d'Etudes Spatiales (CNES), 103
CIP. See Bureau of Communications and Information Policy
ClTEL. See Inter-American Telecommunications Conference
Coast Guard, 59,60
Communications Act of 1934, 101, 107
Comsat, 87, 88, 133
Conference of European Postal and Telecommunications administrations (CEPT), 17, 18-21, 125, 133, 137, 162
  and aeronautical public correspondence, 133
  and Broadcasting-Satellite Service-Sound, 65, 70
  and future public land mobile telecommunications systems, 82
  and high-definition television, 130
  and low-Earth orbiting satellite systems, 118, 125
  and Mobile-Satellite Service, 94

and Space Services, 136
in WARC-92 negotiations, 18-20, 163-164
restructuring of, 20-21
Constellation Communications, Inc., 113, 114
CoveragePlus, 107
CT2 (cordless telephone 2), 78-79, 84

Department of Communications, 47,49
Department of Defense, 69,71, 134, 135, 171
Department of State, 7,40-49, 147, 149, 155-157, 165
Digital audio broadcasting (DAB), 64,66-76
Digital European cordless telephone (DECT), 84
Digital Satellite Broadcasting Corp., 68
Direct broadcast satellite (DBS), 36-37, 129-130
DirecTv, 131
Double sideband (DSB) transmission, 60-61
Dual-mode mobile telephones, 113, 116, 123-124

Earth-Exploration Satellite Service, 140-141
Electronic Industries Association (EIA), 71
Ellipsat, 113, 114
European Community (EC), 20, 84, 106, 119-120, 125, 155, 156-157
European Radiocommunications Office (ERO), 20, 157
European Telecommunications Standards Institute (ETSI), 20
Extra-vehicular activities (EVA), 136

Federal Aviation Administration, 122
Federal Bureau of Investigation (FBI), 59,60
Federal Communications Commission (FCC), 7, 37, 40-49, 149-153, 165
Fixed Satellite Service (FSS), 134-135
Fixed Service, 61
Footnotes, 14,26, 144
Future Public Land Mobile Telecommunications Systems (FPLMTS), 15,77-86, 125, 137

General-Satellite Service (GSS), 139-140, 141
Global Maritime Distress and Safety System (GMDSS), 93
Global Navigation Satellite System (GNSS), 118-119, 123, 157
Global Positioning System (GPS), 118-119
Global system for mobile communications (GSM), 84-86,78,82
Globalstar, 114
GLONASS, 111, 112-113, 118-119, 121-122
Gonets, 104
GTE Airfone, 133

Head of delegation, 166-168
Helrnan, Gerald, 155
HDTV. See Broadcasting-Satellite Service-high-definition television
HFBC-87, 56,58
High-frequency (HF) broadcasting, 11, 55-64, 154, 158-159
High Level Committee, 37, 147
Hubble telescope, 135
Hughes Communications, 131

Industry Advisory Committee, 59,99, 160
Inmarsat (International Maritime Satellite Organization), 26, 88-89, 96-97, 116, 124-126, 133
Intelsat (International Telecommunications Satellite Consortium), 134, 135
Inter-American Telecommunications Conference (CITEL), 21-23, 155,163-165
Interdepartment Radio Advisory Committee (IRAC), 41,48,60,61,72, 154, 158-160
International Civil Aviation Organization (ICAO), 93, 118
International Frequency Registration Board (IFRB), 57
International Radio Consultative Committee (CCIR), 6, 15,53, 147, 155, 163-164
International Table of Frequency Allocations, 11, 26, 52-53, 144
International Telecommunication Union (ITU), 1, 8, 11,27, 146-149
International Telegraph and Telephone Consultative Committee (CCITT), 15, 147, 155
Iridium, 113-116, 120-121, 124, 128, 138

Joint Long-Range Planning Committee, 45-46
Joint Strategic Planning Council, 45

L-band, 35,54,67,69, 144, 154, 157, 161
Land Mobile-Satellite Service (LMSS), 89-90
Leosat, 101
Leosat Panamericana, 104
Lincom Corp., 68
Loral Aerospace Holdings, 68
Loral Cellular Systems, 111-112

Low-Earth orbiting satellites (LEOS), 3,4, 11,26,156
big, 15, 108-128, 144
little, 15,97-108, 144, 157
See *also* Mobile-Satellite Service
Lundberg, Olof, 53

Maritime Mobile-Satellite Service (MMSS), 89-90
Mexico,
and APC, 133
and BSS-Sound, 70, 76, 144
MOB-87, 89, 119, 133
Mobile-Satellite Service (MSS), 4, 11, 15,25,86-128, 146, 151, 171
See *also low-Earth* orbiting satellites
Mobile Service, 4, 77-86
Motorola, 26,29,37, 113, 116, 120, 124, 126, 128

National Aeronautics and Space Administration (NASA), 37-38.134, 137, 165-166
National Association of Broadcasters (NAB), 69,70
National Oceanic and Atmospheric Administration, 105
National Security Council, 60, 158
National Security Directive 51,61
National Telecommunications and Information Administration (NTIA), 7,37,40-49, 149, 153-154, 171
and Interdepartment Radio Advisory Committee, 48-49, 158-160
Negotiated rulemaking, 152
for big LEOS, 117-118, 121, 152
for little LEOS, 103, 106
Norris Satellite Communications, 139
Northwest Airlines, 133

Odyssey, 114
Office of International Communications (OIC), 40
Office of Science and Technology Policy (OSTP), 48
Office of Telecommunications Policy (OTP), 47,48
OmniTracs, 107
ORB-88, 128
Orbcomm, Inc., 101-103
Organization of American States, 21

Pena, Jose Barrionuevo, 10
Personal communication networks (PCN), 84, 85
Personal communication services (PCS), 4, 73, 77, 78-86, 125, 137, 151
FCC proceedings on, 79-82
Plenipotentiary Conferences of ITU, 15
Special Plenipotentiary of 1992, 11, 147
Primosphere, L. P., 68
Private sector, 27-29
domestic policymaking and, 28-29,32-33, 34-35
role in international negotiations, 27-28
Project Acorn, 68
Project 21, 116-117

Qualcomm, 107
Quayle, Dan, 26

Radio astronomy, 101, 105, 111, 122-123
Radio Free Europe/Radio Liberty, 59
Radio Moscow, 55
Radio Regulations, 57, 136
Radiocommunication policymaking
implications of WARC-92 for, 30-39
long-range planning and, 36-38
market forces and, 30-36
options for improving, 39-49
structural problems, 158
Resolution 46 (COM5/8), 111, 120

S-band, 70, 161
Satellite CD Radio, 67-68, 70
Senior Interagency Group, 45
Shortwave, 55
Single sideband (SSB) transmission, 58-59,63
Sky-Highway Radio Corp., 68
Smolsat, 104
Space Frequency Coordination Group (SFCG), 37-38, 137, 141
Space Services, 5, 105, 135-139, 151
Space shuttle, 135, 138
Space Station Freedom, 135, 138
Starsys, Inc., 101-103
Strother Communications, 68

Taos satellite system, 104
Task Force on ITU restructuring, 15,40, 147
TDMA (time division multiple access), 116, 121, 122, 124
Tracking and data relay satellites (TDRS), 134, 138
TRW> Inc., 113, 114

USA Digital Radio, 68
U.S. Air Force, 105
U.S. Information Agency (USIA), 59, 158
U.S. Trade Representative, 46-47, 156-157
United States Satellite Broadcasting, 131
United States Telecommunication Training Institute (usT-rI), 166

Voice of America (VOA), 55,57,59-61, 158-159
Volunteers in Technical Assistance (VITA), 101-103

WARC-92
background, 2,9-15
factors affecting implementation, 144-157
implications for policy, 30-39
structure, 10-11
themes and trends from, 15-29
U.S. delegation, 9-10, 168-169
U.S. negotiating strategies, 169-171
WorldSpace, 71

Superintendent of Documents Publications Order Form

Order Processing Code:
"7078

P3

Telephone orders (202) 783-3238
To fax your orders (202) 512-2250

Charge your order.
/t's Easy!

❑ YES, please send me the following:

_____ copies of *The 1992 World Administrative Radio Conference: Technology and Policy Implications (200 pages)*, S/N *052-003 -01322-3* at $11.00 each.

The total cost of my order is $_____. International customers please add 25%. Prices include regular domestic postage and handling and arc subject to change.

(Company or Personal Name) (Please type or print)

(Additional address/attention line)

(Street address)

(City, State, ZIP Code)

(Daytime phone including area code)

(Purchase Order No.)

Please Choose Method of Payment:

❑ Check Payable to the Superintendent of Documents
❑ GPO Deposit Account _____ — _____
❑ VISA or MasterCard Account
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 _____

(Credit card expiration date)

Thank you for your order!

(Authorizing Signature) (5,'93)

YES NO
May we make your name/address available to other mailers'? ❑ ❑

Mail To: New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954

THIS FORM MAY BE PHOTOCOPIED